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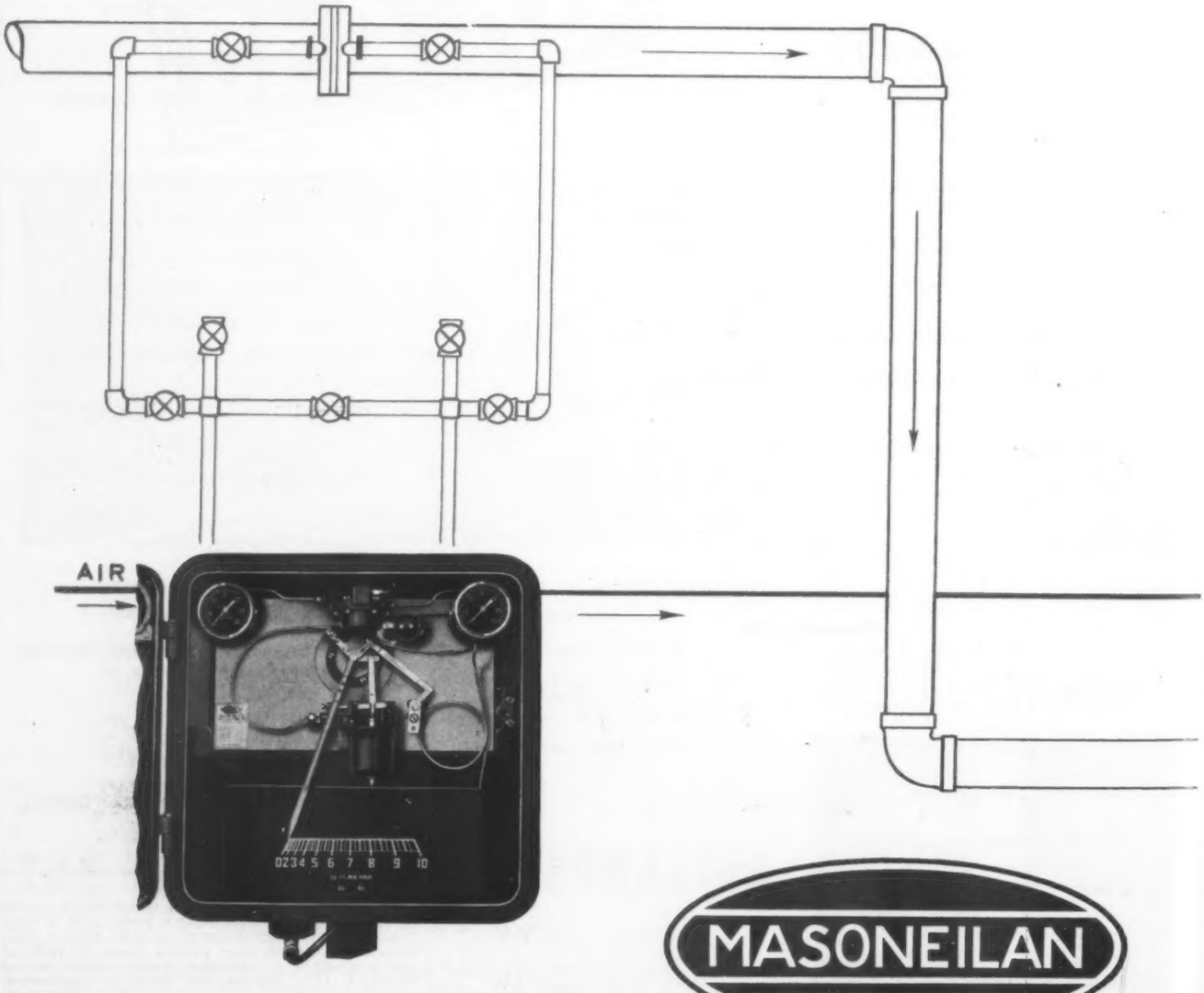

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VOLUME 19, No. 12 DECEMBER, 1940

REFINER
AND NATURAL GASOLINE MANUFACTURER

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The Look Box

FOR whatever it is worth, the petroleum industry can substantiate its plea for continuation under free enterprise with a status not matched by any other industry. Even those being driven by agencies of government and financed by public funds do not offer as much for the national defense program as does oil.

Accomplishment Belies Control

At the last meeting of the American Petroleum Institute, Dr. Robert E. Wilson said that only limited building of additional units for high-octane gasoline would be needed and this not before the training program reaches its peak within 18 months.

More recently William R. Boyd, executive vice president of the institute, in a nation-wide broadcast, said:

"Bottlenecks, the bane of many industries, are conspicuous in petroleum by their absence. Limited expansion of refinery capacity to augment the output of super fuels, already greater than all our planes can consume; adaptation of marine transportation facilities; extension of pipe-line mileage in some strategic areas; and construction and relocation of some storage facilities to increase capacity and security constitute all the military experts find necessary for the full preparedness of the industry."

All of this has been done without aid or urging by government, which causes wonder that some officials in Washington still insist that some form of control, centered in Washington, should be instituted. Until government control of some other industry matches what petroleum has done of itself, there is no justification for that attitude.

Equally difficult to understand is the attitude within some divisions of the industry. There are men engaged in the petroleum industry, whose investments are substantial, who continue to talk and act in harmony with the pleas of men in positions at Washington. Usually they propose some control agency which will have only governmental supervision.

Since these men are engaged in the oil business for the purpose of profit, the logical conclusion is that they expect more profit through these methods of supervision. How they justify the expectation that an agency of government will supervise, when it has authority to control, is beyond calculation. From supervision, actual control is the next step. Should control come, the profit motive will become secondary.

It would seem that the industry has in its accomplishments a fitting bit of evidence to thwart efforts at control. If its own personnel, however, continues to move in that direction, seekers of federal legislation can base their proffered legislation on what the industry wants.

All in all, it would seem that the industry, provided free enterprise is a desirable status, had best continue at what it is doing and let all pleas for control come from those whose only objective is control.

WHAT process development, especially the catalytic methods, mean to petroleum has been tersely stated by authors Gustav Egloff, J. C. Morrell and Sophia Berkman in their work Catalysis:

"Thus, the foundation has been laid for an improved petroleum industry and for a synthetic chemical industry utilizing petroleum as a raw material for the production of a myriad of catalytic products referred to above, which heretofore have been known only as coal-tar derivatives. Dehydrogenation, polymerization, de-polymerization, alkylation, isomerization, hydrogenation and cyclizaton—these are some of the methods by which these products may be obtained catalytically. Simultaneous with the production of commodities useful to mankind has been the development of a hydrocarbon chemistry which has furnished chemists with tools heretofore known for investigation of hydrocarbon reactions."

Refining Approaches Chemical Processing

Science has made sufficient progress to make crude oil of further use to men and women. What seems to be lacking is a civilization geared to use scientific progress for development rather than destruction.

WHILE the anti-knock rating of gasoline has risen steadily in 10 years its price at the service station has decreased, a pair of contrary trends set forth by Ethyl Gasoline Corporation in these words:

"So great has been the advancement in refinery technology during the past 10 years that the oil industry is able to supply gasoline of the necessary anti-knock quality at even lower prices than prevailed in 1930—12.58 cents at service stations, without tax, in the nation's 50 largest cities today, as compared with 15.42 cents in October, 1930, and 30 cents in 1920."

High Compression Lower Price

That the industry faces the necessity of further stepping up its anti-knock rating of gasoline is the opinion of Earl Bartholemew, automobile engineer on the Ethyl staff, who thinks 95-octane gasoline will be sold at service stations within 5 years. Such fuel in his opinion may result in an improvement in economy of 35 percent or more, with performance even better than it is today. Smaller engines and still higher compression ratios are in prospect.

Compression ratios for 1941 automobiles showed the sharpest jump in such ratios that the industry has adopted. The average is 6.66 compression ratio and 115 horsepower. Last year the compression ratio average was 6.43. There are 10 models with ratios of 7 to 1 or higher.

Meanwhile the engineering laboratories have completed successful tests with engines of 11 to 1.

A question before the industry concerns the price trend with the anti-knock trend definitely upward.

RECYCLING, which is an improper word for describing recovery and conversion, from a condensate-type field, is making a bid for a place in manufacturing. It has 23 plants, which process 1,081,500,000 feet of gas daily and recover 1,018,000 gallons of finished products in a day. Five plants under construction will add another 700,000 gallons of output daily. Another 200,000 gallons of finished product are promised in plants under consideration.

Recycling Is Growing Up

Much of this recovery is motor fuel and kerosene, which places the recycling plant in competition with the refining plant.

SO MUCH is said and written about processes that men are ignored, in particular the men who operate the equipment. Those responsible for inventions or well enough versed in theory to prepare papers get the limelight whether they seek it or not.

Even in these deliberations, however, the versatility of plant workmen draws praise. Recently discussion of a new catalytic process brought the question of training personnel.

Men Are the Answer To Process Success

"Men who know thermal cracking soon catch on," was the terse reply. It was a tribute to the thousands of men who are short on formal education but long on practical ability.

Study of an effective safety program soon reveals that workmen are responsible for its success. The plan comes from management, but the best plan is one which permits men to suggest their own methods. The plant idea surpasses the office suggestion for the reason that it is more welcome and it holds possibility of accomplishment, since the man who makes the suggestion knows it can be done. Thus, safety does not seek impossible goals.

No process and no executive plan is any better than the men to whom it is passed. In refining, the laboratory and the office are effective, at least in part, because workmen are capable and adaptable.

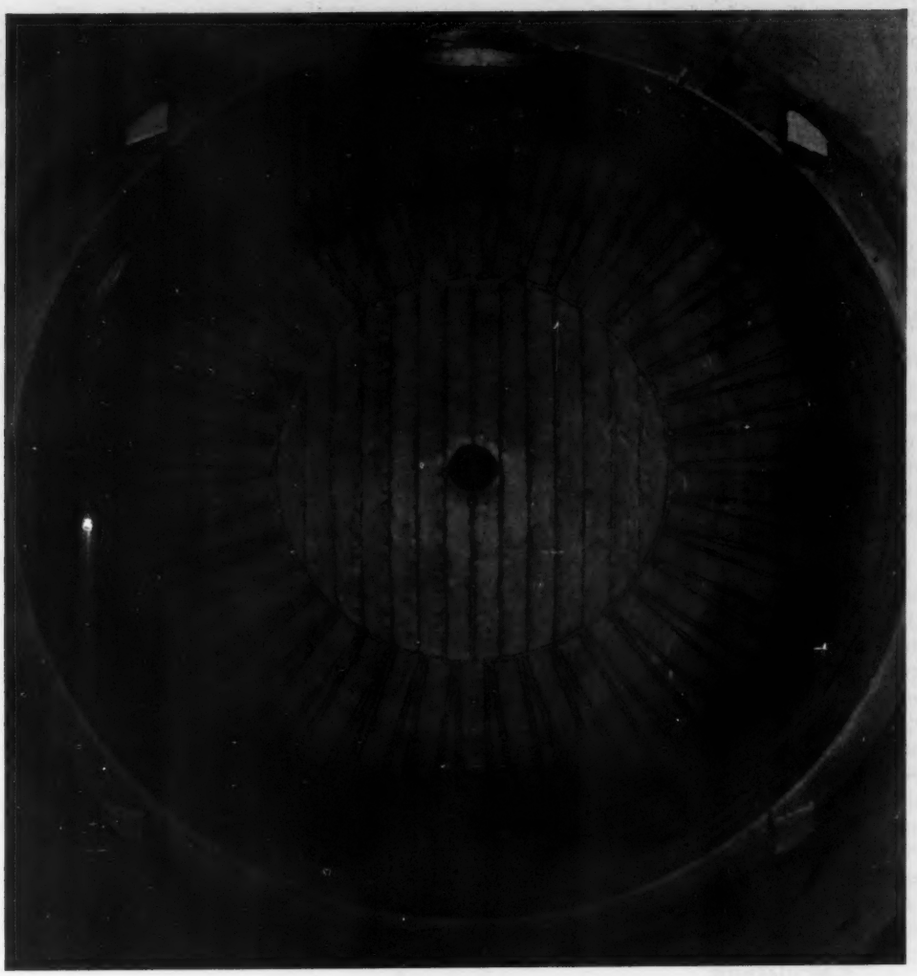


FIGURE 6
Plan View of Bottom Head.

Layout and Application of Stainless Strip Lining to Refinery Vessels

By W. W. McCLOW
Assistant General Maintenance Foreman Toledo Refinery,
The Pure Oil Company

CONSIDERABLE literature has been written concerning the benefits to be derived from the application of stainless-steel linings to refinery vessels subjected to various corrosive services. Assuming, therefore, that the reasons for using such linings are well established, this discussion will be confined alone to the mechanics involved in laying out and applying a stainless lining to an actual vessel. In the particular case under consideration a 12-gauge lining with an analysis of 12 to 14 percent chromium, 0.08 percent maximum carbon, was applied in the form of 4-inch strips to a fractionating tower having an inside diameter of 8 feet 6 inches. All surfaces to be lined were thoroughly cleaned and sand-blasted before proceeding with the lining application.

Application of Lining to Bottom Head

General Description

The tower head under discussion is described as a semi-ellipsoidal surface generated by a semi-ellipse rotating about its minor axis and having a ratio between its major and minor axes of 2 to 1. Such a surface is

known generally as an ellipsoid of revolution or specifically as an oblate spheroid.

Although this discussion deals with a head having the shape of an oblate spheroid, it should be noted that the same line of reasoning and lay-out methods would be equally applicable to prolate spheroids as well as the sphere itself, although there is no evidence available to indicate that the former is used to any extent for refinery vessels. A prolate spheroid is distinguished from an oblate spheroid by the fact that it is generated by an ellipse rotating about its major axis instead of its minor axis. The sphere is a special case of the spheroid in which the major and minor axes are equal in length.

Basis for Selection of Design

After having reviewed past experiences with towerhead linings it was decided that an effort should be made to reduce costs of liner application and produce a more satisfactory installation in general. Accordingly, preliminary lay-outs and templates were made in the office to determine the limitations of various conceivable designs.

Referring to Figure 6, which is a photograph showing the design finally adopted, it was found that at least one ring of radial strips would be needed to produce conformity to the sharp change of curvature occurring at the outer extremities of the semi-ellipsoid. It was evident that the most economical design would result from only one such ring, this to surround a circular patch in the center and consist of alternate rectangular and wedge-shaped strips. The inside diameter of the ring was calculated and laid out on the generating ellipse to determine the feasibility of the arrangement. The bottom portion of the ellipsoid proved to be sufficiently flat to permit the installation of a central patch of the diameter described and on the basis of this determination it was decided to adopt the design.

Calculations

Number of Radial Strips Required in Ring

In order to determine the proper number of radial strips required to build up the outer ring shown in Figure 6, it was necessary to first decide upon the desired width of spacing between adjacent strips. Former experience had shown that by proper fitting and welding technique this spacing could be maintained at approximately ¼ inch. With this assumption calculations were carried out as follows:

Inside diameter of tower.....102 inches
Width of lining strips..... 4 inches
Width of spacing between strips..... ¼ inch

Let N = Total number of radial strips
Then $4.25\ N = 102\pi$
Solving, $N = 75.4$

Since it was desirable to have a whole number of strips for lay-out purposes and since it was also necessary to decide upon an even number of strips in order to carry out the alternating relationship between rectangular and wedge-shaped strips, the choice was limited to either 74 or 76 strips. It was decided more economical to adopt 76 strips and if necessary provide for a slight increase in spacing when cutting the wedge-shaped strips than to fill in by welding the extra spacing which would be created by using only 74 strips. Accordingly, the design was set up on the basis of 76 strips.

Inside Diameter of Ring

It was obvious that the wedge-shaped strips in the outer ring should not be brought to a point at the narrow end for the reason that the welds on opposite sides of the strip would fuse into each other as they approached the point and in effect be equivalent to nothing more than an excessively wide single weld. A width of approximately ⅜ inch was considered satisfactory for the narrow end and on the basis of this assumption, calculations were carried out as follows:

$$\text{I.D.} = \frac{(38 \times 4\tfrac{3}{8}) + (76 \times \tfrac{1}{4})}{\pi}$$

Solving, I.D. = 59 inches

Preliminary Lay-out

It is obvious that after the lining design had been adopted, templates could have been developed on the job as installation progressed. However, preliminary lay-out work and template development was considered advisable in order to check the feasibility of the design before installation and to determine the most economical lay-out from the standpoints of scrap loss and labor requirements for cutting liner material into the desired shapes.

Development of the Ellipse

The following development was carried out for the purpose of reproducing the semi-ellipse used in generating the ellipsoidal head under consideration.

By definition an ellipse is the locus or path of a point which moves so that the sum of its distances from two fixed points remains constant. The fixed points are known as the foci and the sum is equal to the length of the transverse or major axis.

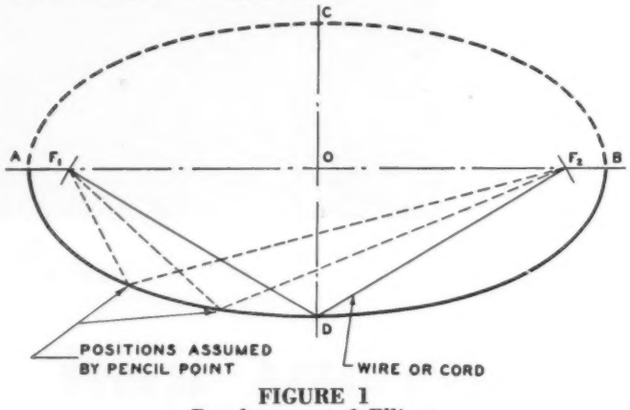


FIGURE 1
Development of Ellipse

Referring to Figure 1, AB is the major axis and CD the minor axis. For the particular tower under consideration AB was drawn equal to the tower diameter of 8 feet and 6 inches. Since the ratio between the major and minor axes was 2 to 1, the length of the minor axis was 4 feet and 3 inches. The lengths of the two axes were the only known quantities and therefore were necessarily the basis for further development.

Foci F_1 and F_2 were located by cutting the major axis AB with an arc having its center at C or D and a radius equal to AO or OB. Nails were driven at points F_1, F_2, and D and a flexible wire was drawn tightly around D with the ends tied at F_1 and F_2 as indicated. The ellipse was described by removing nail D and moving a pencil point in the loop in such a manner as to keep the wire taut at all times.

Although there are several other methods of drawing ellipses, some of which are accurate and some approximate, the method described is probably the best suited to developing a true, full-size ellipse of the dimensions specified.

Development of Circular Patch

The following development is approximate and was carried out primarily for the purpose of providing tem-

plates for cutting strip lining into shapes which could be fitted into the desired circular patch with a minimum of final trimming.

Template development for the circular patch was carried out as outlined in Figure 2. Referring to the sectional elevation, the length of the elliptical curve lying between points 0 and 1 was determined by bending a paper strip to conform to the ellipse, marking at the above points, and measuring the distance between the marks after the strip had been straightened out again. It was considered advisable to add approximately ¼ inch to this distance to compensate for inaccuracies which might exist in the tower head. A circle with its radius equal to this sum was drawn and then divided as indicated into 4-inch strips with approximately ¼ inch existing between adjacent strips. The 4-inch strips thus formed represented the finished templates.

Development of Outer Ring

As previously stated, the outer ring in the particular case being described was composed of a total of 76 alternating rectangular and wedge-shaped strips.

A wedge-shaped strip was laid out in horizontal projection as shown in the plan view of Figure 2. The center line of the wedge was divided into equal segments of convenient length, 1 inch being used for the case described. The end points of the segments were marked 1, 2, 3, etc., and lines perpendicular to the center line were drawn through these points to cut the sides of the wedge. Points 1, 2, 3, etc. were then projected vertically downward to the ellipse as shown in the elevation. Distances along the curve between successive points were laid out by bending a flexible strip to the contour of the ellipse, marking it at the points described and again straightening it out. The marks thus produced were projected to a new center line and a series of vertical

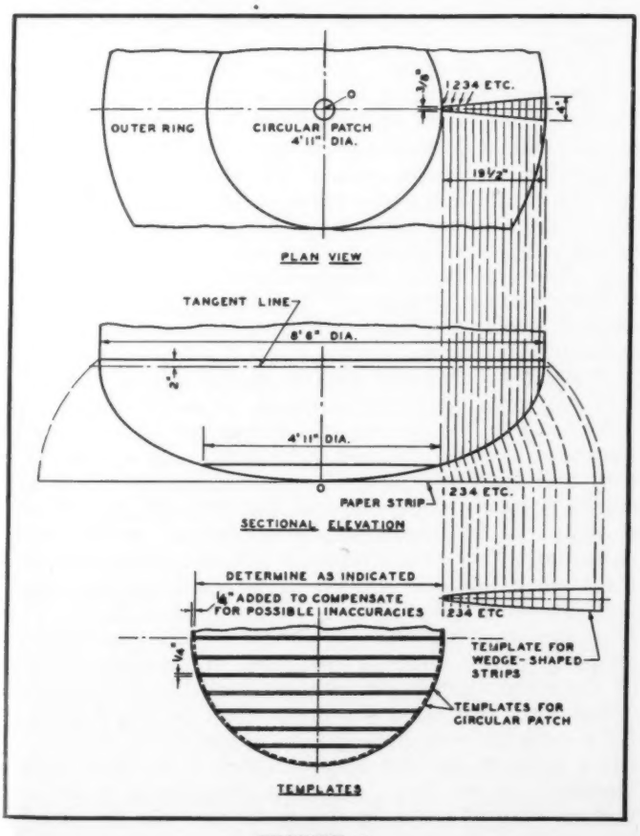


FIGURE 2
Head Layout

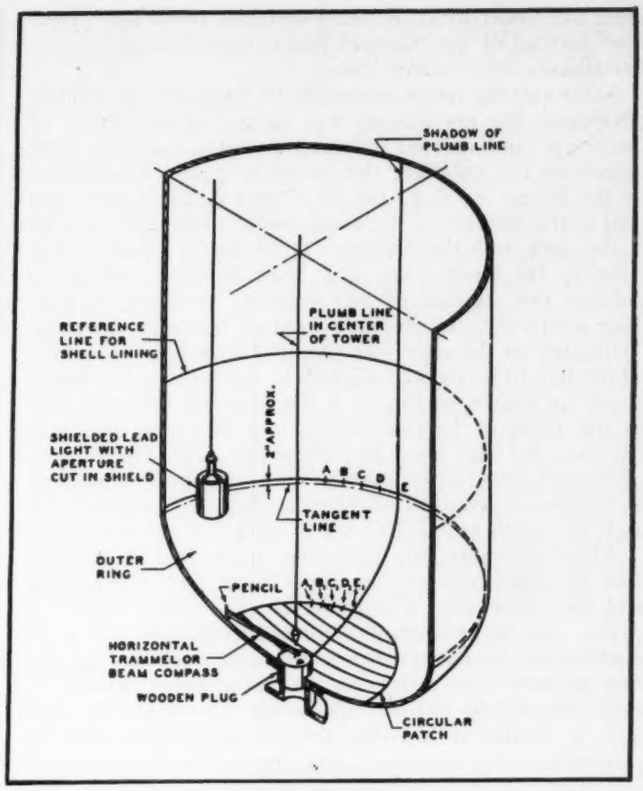


FIGURE 3
Tower Layout

lines were drawn through the projected points perpendicular to the center line and equal in length to corresponding lines in the plan view. The template was completed by joining the terminal points of the vertical lines as shown.

The foregoing development was essential to an intelligent analysis of the job. However, lining material was not cut according to the wedge-shaped template until all rectangular strips had been completely welded in place and an opportunity given for checking the template against the actual installation. A perfect fit was obtained by using the original template; however, had there been any appreciable inaccuracies in fabricating the tower head or in carrying out preliminary lay-outs and calculations, it is obvious that alteration of the template would have been necessary.

All rectangular pieces in the outer ring were straight 4-inch strips equal in length to the wedge-shaped strips discussed in the paragraph above.

Lay-out of Tower Head and Application of Lining

In order to derive full value from the preliminary lay-outs, calculations, template developments, etc. already discussed, a highly accurate lay-out of the tower head was made preparatory to the lining application. Details of the lay-out used are outlined in Figure 3.

Lay-out for Installation of Circular Patch

As shown in Figure 3, a round wooden plug was fitted snugly into the bottom tower nozzle with the top at approximately the same elevation as the position designed for the edge of the circular patch. A wooden trammel was then fitted with a pencil at one end and a nail at the other, spaced so that the distance between them was equal to the radius of the patch in its horizontal projection. The trammel was placed in a horizontal position with the nail driven into the center of the plug and the pencil at the opposite end free to bear

upon the tower head. A beam compass could have been used instead of the trammel had it been desired.

Installation of Circular Patch

After cutting strips according to templates previously developed, the installation was started at the center of the tower and carried outward simultaneously in both directions by installing the strips in pairs as indicated by the letters A, B, C, etc. in Figure 4. Each strip was bent to the contour of the head, laid in place, and marked at the ends with the trammel. With the strip still in this position its inner edge was checked and marked to indicate the removal of any material necessary to produce conformity to the edge weld of the adjacent strip. Trimming of the edge was required only by those strips which had to be twisted slightly to conform to the tower head. As shown in Figure 4 the material removed was in the form of narrow slivers and in every case was cut from the edge near the ends of the strip. The amount of wasted material represented was negligible inasmuch as the pieces removed never exceeded approximately 12 inch in length and 3/16 inch in width at the wide end.

After trimming, the strip was again laid in position and its edges welded, the inner with tack welds only and the outer with a continuous edge weld. Figure 4 shows the approximate sequence adopted for weld application. As indicated, a continuous weld was applied first to one edge only and the sheet then allowed to cool thoroughly before completing the opposite edge with a similar weld. This procedure, accompanied by proper welding technique, was responsible for eliminating cracks resultant from contraction of the sheet. The extreme importance of welding with as low a heat as possible was recognized and all welds were made accordingly. Each weld was completed in two passes. The first took the form of an edge weld as previously stated and was run to slightly overlap the edge of the sheet in order to produce proper penetration. The second was run to slightly overlap the edge of the adjacent

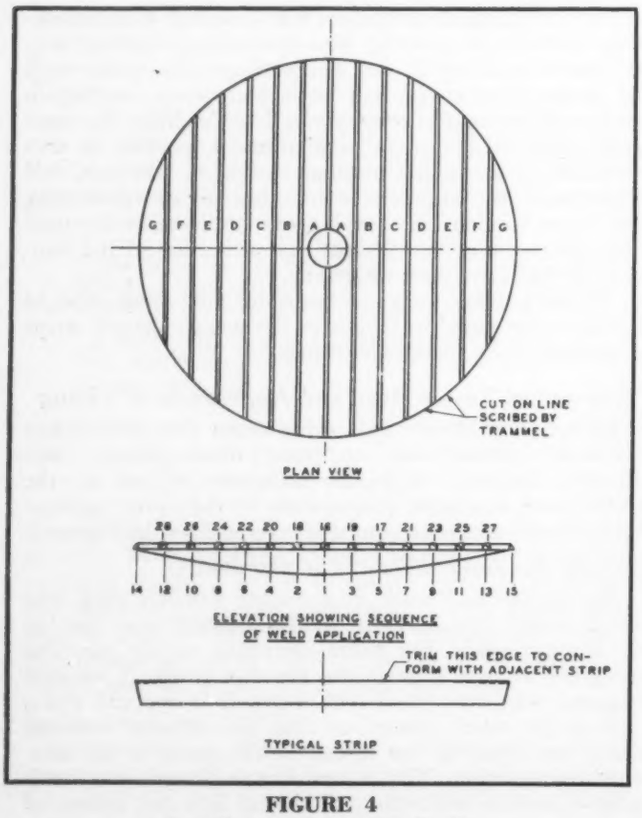

G F E D C B A A B C D E F G
CUT ON LINE SCRIBED BY TRAMMEL
PLAN VIEW
26 25 24 22 20 18 16 19 17 21 23 25 27
14 12 10 8 6 4 2 1 3 5 7 9 11 13 15
ELEVATION SHOWING SEQUENCE OF WELD APPLICATION
TRIM THIS EDGE TO CONFORM WITH ADJACENT STRIP
TYPICAL STRIP

FIGURE 4
Installation of Circular Patch

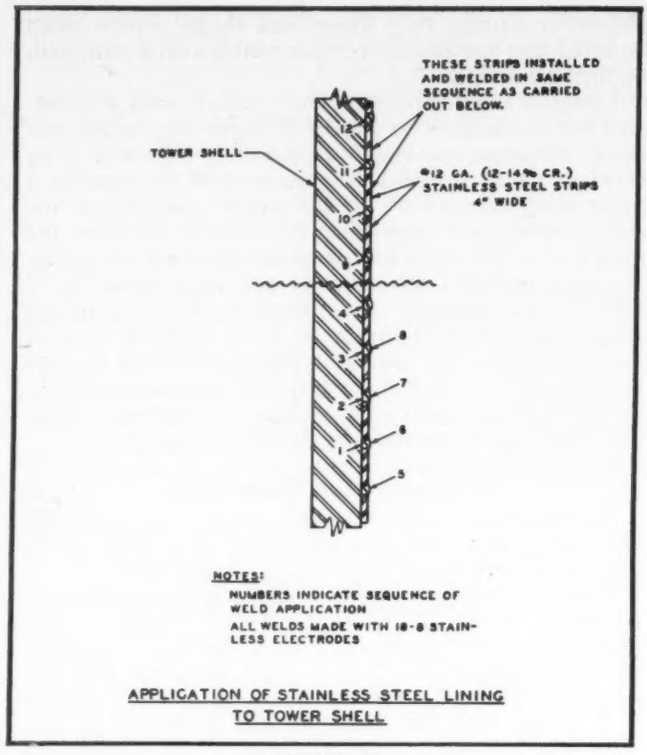

THESE STRIPS INSTALLED AND WELDED IN SAME SEQUENCE AS CARRIED OUT BELOW.
TOWER SHELL
#12 GA. (12-14% CR.) STAINLESS STEEL STRIPS 4" WIDE
NOTES:
NUMBERS INDICATE SEQUENCE OF WELD APPLICATION
ALL WELDS MADE WITH 18-8 STAINLESS ELECTRODES
APPLICATION OF STAINLESS STEEL LINING TO TOWER SHELL

FIGURE 5

sheet and completely cover the first weld. This method proved to be very satisfactory and more economical than any other tried previous to its adoption.

Lay-out for Installation of Radial Strips

The method used for laying out the tower head preparatory to the application of alternate rectangular and wedge-shaped strips in the outer ring is shown in Figure 3.

The circumferential reference line indicated was established by using a surveyor's level set up in the bottom of the tower and focusing the telescope upon a pencil point held against the tower shell. It was decided to terminate the outer ends of all radial strips at a line running parallel to and approximately 2 inches above the tangent line of the head. This position was determined by measuring down from the reference line and was chosen to make certain that all strips would be run beyond any curvature in the head which might have existed above the theoretical tangent line due to inaccuracies in fabrication.

It was realized that if the cost of this type of installation was to be kept at a minimum, all radial strips of a given kind should be exact duplicates cut to a standard template. In order to meet these conditions it was evident that the center line of each strip should lie along a true element of the ellipsoid (an element appears as a radius of the head in its horizontal projection). Accordingly, the circumferential line immediately above the tangent line was laid off in 38 equal segments, the ends of which are shown in Figure 3 as A, B, C, etc. to designate center line positions for the rectangular strips. A plumb line was then hung in the exact center of the tower to coincide with the axis. Shadows of the string were cast upon the tower shell by using a lead light covered with a shield in which there had been cut a vertical aperture approximately 1/16 inch wide. Geometry states that a plane is determined by a line and an external point. In this particular case the plumb line satisfied the first condition while the light fulfilled the second. Together they determined diametral planes

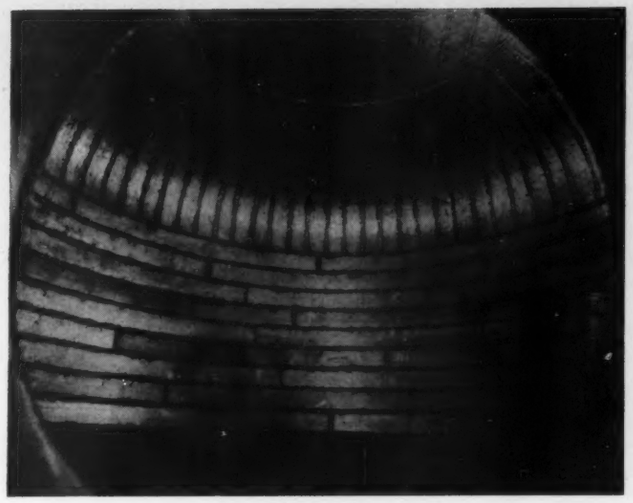


FIGURE 7
View of Bottom Tower Section Through Manway

which intersected the tower shell in the form of shadows. It is obvious that since all planes thus formed passed through the axis of revolution of the ellipsoidal head, all shadows falling on the head lay along true elements of the ellipsoid.

The light was moved so the shadow of the plumb line passed progressively through points A, B, C, etc. For each of these positions the intersection of the shadow with the edge of the circular patch was marked. These points, indicated by A_1, B_1, C_1, etc. in Figure 3, were prick-punched for permanency.

Installation of Radial Strips

The first rectangular strip was installed with one end at A and the other at A_1 such that its center line passed through the points. One edge was welded with a continuous edge weld while the other was tack welded. After all 38 strips had been installed in this manner the tacked edges were completed with continuous welds applied in the same sequence used for installation of the strips.

The template previously cut for the wedge-shaped strips was checked against the spaces existing between the rectangular strips, and excellent conformity was found. Strips were cut according to the template and installed in a manner similar to that described for the rectangular strips. Tack welds were applied to one edge while a continuous weld was run along the other to slightly overlap the edge and cover completely the weld previously applied to the adjacent rectangular strip. After all wedge-shaped strips had been installed, the tacked edges were completed in a manner similar to that just described.

Application of Lining to Shell

A 12-gauge stainless steel lining in the form of 4-inch strips was applied to the tower shell as shown in Figure 7.

Lay-out of Tower Shell

In order to facilitate accurate fitting of the lining strips, circumferential reference lines were drawn in true sections of the tower. As discussed under head lay-out, the first of these, indicated in Figure 3, was established by using a surveyor's level. As the installation progressed upward, successive lines were laid off as required by measuring back to the preceding line. One of these lines can be faintly seen on the shell immediately above the lined section shown in Figure 7, which is a photograph of the actual installation. Accurate fitting of the strips was made possible by keeping their edges parallel to the reference lines described, thereby preventing the twisting of sheets and a resultant lack of uniformity in spacing.

Fitting and Welding

All strips were fitted and welded as shown in Figures 5 and 7. As indicated in Figure 5, all work proceeded from the bottom to the top of the section being lined. Each successive strip was installed by moving it down until its bottom edge came into contact with the edge weld of the strip below. The bottom edge was then tacked in place and a continuous edge weld run along the top edge. Four or five complete rings were thus installed before dropping back to weld the bottom edges, which were completed in the same order. By this method, time was allowed for dissipating the heat produced by welding the top edges. As a result, cracking of the sheet was reduced to a minimum. All bottom edge welds were applied as shown, by producing a sufficiently wide bead to slightly overlap the edge and cover the weld previously laid along the top edge of the sheet below. All welds thus completed in two passes, every effort being made to reduce deposition of weld metal to a minimum consistent with good practice.

Application of Lining to Manways

Figure 8 is a photograph showing the application of 4-inch strip lining to a tower manway. The same procedure was used in this installation as already described for the application of lining to the tower shell.

Conclusions

Success or failure of the lining applications described depended largely upon the thoroughness and degree of accuracy carried out in preliminary analyses as well as in the actual tower lay-out and application of lining material. No amount of preliminary work could have compensated for inaccurate or careless workmanship in the tower, however, and for that reason irregular welds or discrepancies of more than 1/16 inch in fitting were not permitted. As a result of careful planning and accurate application, the installation met every expectation as to economy and quality of workmanship.

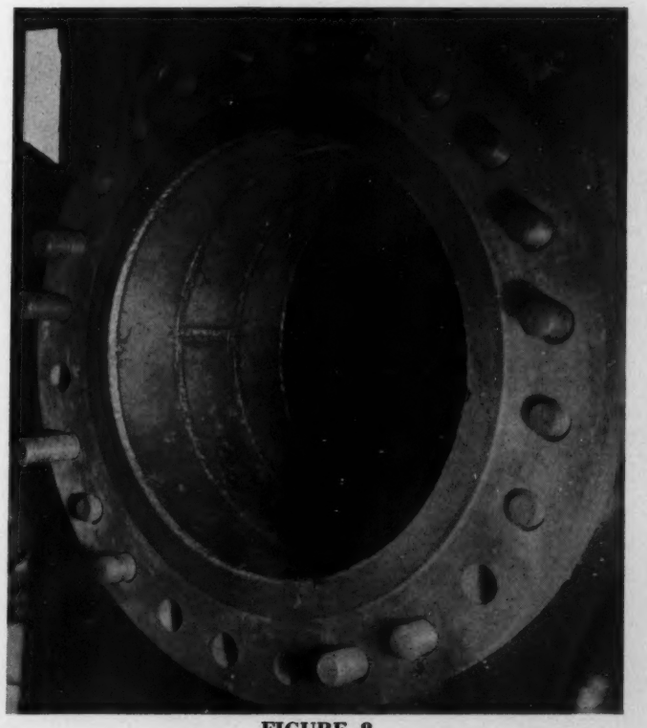


FIGURE 8
View of Manway Lining

Evaluation of Steels For Cracking Tube Service By Stress-Rupture Tests

C. L. CLARK
Research Engineer, Dept. of Engineering Research, University of Michigan
and
W. G. HILDORF
Chief Metallurgical Engineer, The Timken Roller Bearing Company

VARIOUS high-temperature-strength characteristics are in use for the design of high-temperature equipment. Many still employ the short-time high-temperature tensile strength while others resort to the results from prolonged creep tests, or certain modified creep tests such as the Hatfield's time-yield method. While each of these possess certain advantages, as well as disadvantages, it is believed that they do not reveal all of the information necessary to predict the suitability of a given steel for use in cracking still service.

Before discussing other methods of evaluating steels for this purpose it is well to briefly review the conditions which may be imposed upon cracking-still tubes. If an oil temperature of 950° F. is assumed then the metal temperature at the start of the operating cycle will vary, depending upon the heat transfer rate, the oil film coefficient and the tube-wall thickness, and will probably be of the order of 1100 to 1150° F. in a typical installation. As the run continues, coke may deposit on the inner wall and, due to its insulating effect, the tube temperature will rise. At the end of a 30-day operating cycle, skin temperatures of 1350 to 1400° F. may be attained.

It often has been stated that the major portion of the deformation, as well as actual fracture if it occurs, takes place during the latter part of the operating cycle, that is, during the overheating and thus overstressing stage. If this is the case then it must follow that the rate of deformation during this period is much more rapid than commonly employed in the creep tests. Furthermore, it is known that the relative order of strength of a series of steels may vary depending upon the rate of deformation employed in their classification.

Likewise in cracking-still applications it is customary to judge the life of a tube by the amount of visual deformation or bulging. It is therefore of importance to know the extent to which a steel will deform before actual failure occurs. None of the short-time tests, or the prolonged creep test, yield information with respect to the influence of time, temperature and stress on the hot ductility up to fracture.

The authors believe that the stress-rupture test affords a convenient means of evaluating steels for this type of service and in the following sections will discuss its use for indicating the load-carrying ability, for determining the hot ductility up to fracture, for showing the surface and structural stability and likewise its possible use in rapidly classifying steels of the same general type as well as serving as an acceptability test. It should be pointed out, however, that it is not the authors' intention that the stress-rupure test entirely replace the creep test. Rather it is believed that for this particular type of service the two should supplement each other.

Procedure

In the stress-rupture tests, a series of specimens of each steel at each temperature are broken under constant stress with the stresses being so selected that fracture will result over time periods varying from a few minutes up to a maximum of several hundred or several thousand hours. In our laboratories, a hydraulic tensile machine is used for fracture periods up to 15 hours while the more prolonged tests are conducted in dead weight machines of the type shown in Figure 1. This photograph shows 10 of the 22 units in operation.

The equipment is much simpler than that used for creep tests as no extensometer is required since it is not necessary to measure the rate of deformation of the specimen. If desired, however, fairly definite deformation curves can be obtained by the use of a calibrated spirit level gauge on the loading beam. It is recognized that the resulting time-elongation curve is not as accurate as that obtained in standard creep units but it is believed ample for the purpose since the deformation rate is in general relatively rapid and during from ½ to ⅔ of the test the specimen is in the so-called third stage of creep, that is, the stage of increasing creep rate with time.

If the stresses and corresponding fracture times are plotted to cartesian coordinates then curves of the type shown in Figure 2 will result. These curves appear to become asymptotic to definite limiting stresses and it is thus possible to obtain an indication of the stress below which fracture will not result for very extended time periods.

It has been found, however, that a more definite relationship exists when the results are plotted to logarithmic coordinates. If the steel possesses a sufficient degree of both surface and structural stability under the given test conditions, then this method of plotting results in a single straight-line relationship over the entire time period considered. This condition is represented in Figure 3.

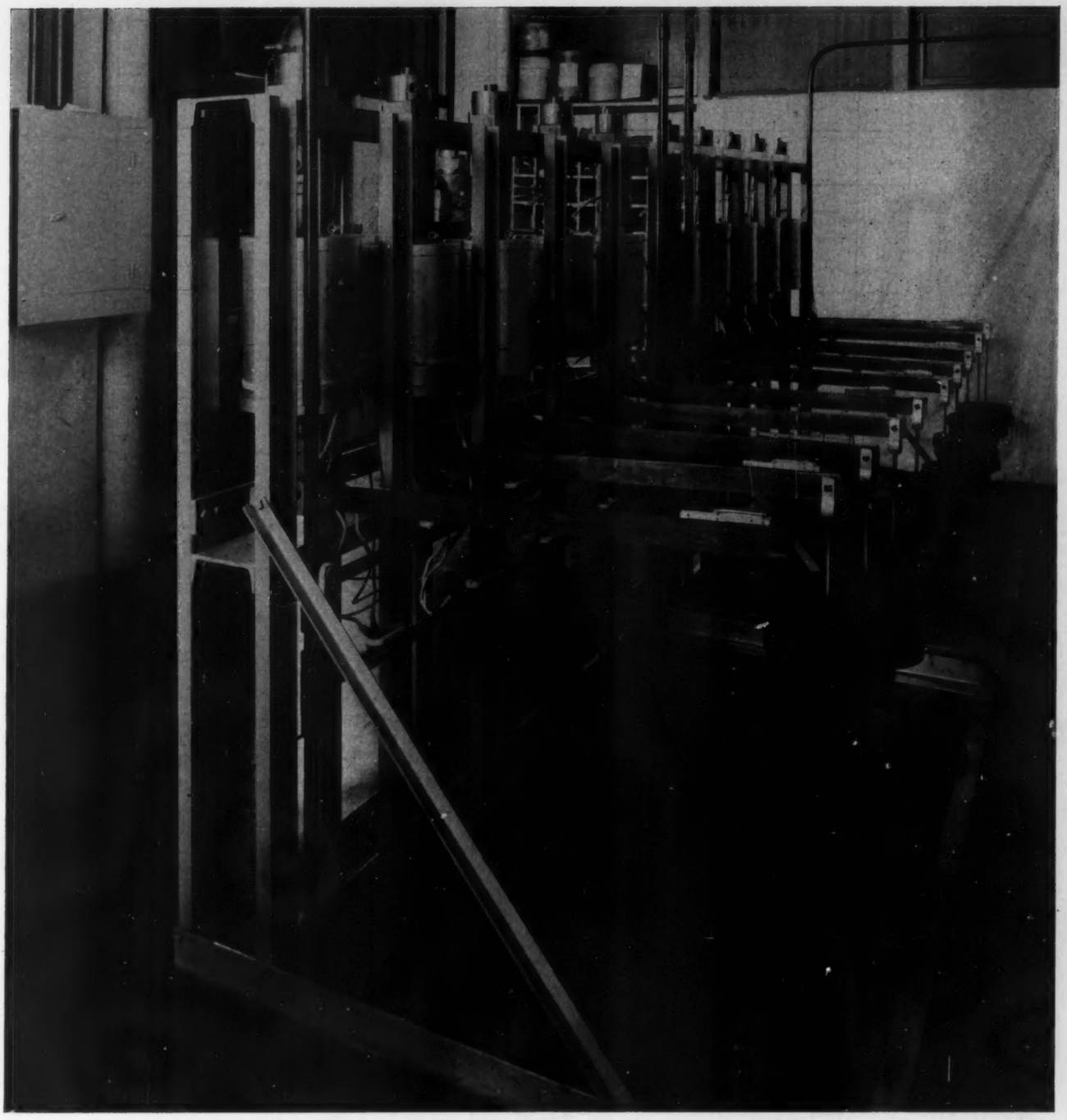


FIGURE 1
Photograph of a Battery of Ten Stress-Rupture Units

If, on the other hand, the steel is lacking in either type of stability, then a break will occur in the straight-line relationship after a certain time period, as shown in Figure 4. After the break has once occurred, however, a straight-line relationship again results but it has a steeper slope than that of the original line. This has been substantiated by several tests of 10,000 to 20,000 hours duration. In the case of Figure 4 the break in the relationship at 1200 and 1300° F. is mainly due to lack of sufficient resistance against oxidation.

The relationships of Figures 3 and 4 permit the determination of the stresses required for various fracture time periods. Because of the definite relationship which exists and the certainty of the values, that is, stress and fracture time, extrapolation is believed permissible for time periods up to 100,000 hours. At least this is believed to be more justified than in the case of the creep results for the creep rate may vary greatly depending upon the time used for its determination.

The stresses for fracture time periods varying from 1 to 100,000 hours, as determined from the type relationship shown in Figures 3 and 4, may be plotted against temperatures, as in Figure 5. As will be discussed later, curves of this type are of value in indicating the behavior of a given steel under overheating and thus overstressing conditions.

A measurement of the elongation and reduction of area of each of the individual rupture specimens will

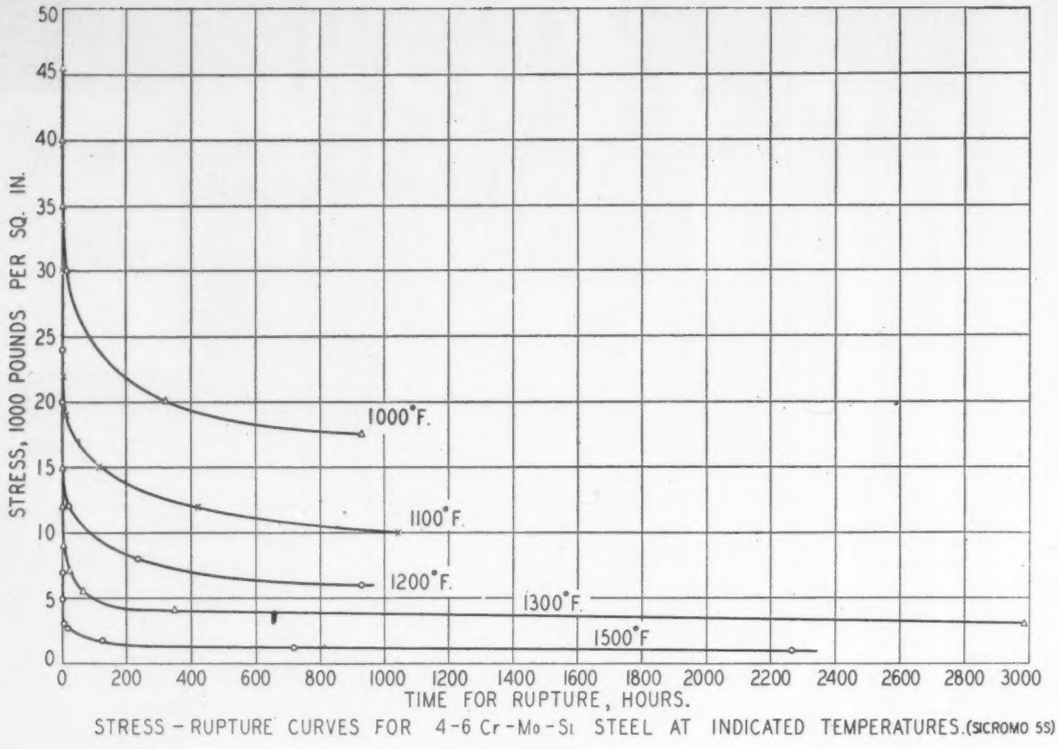


FIGURE 2

indicate the influence of time, temperature and stress on the hot ductility up to fracture while a metallographic examination of the specimens will show the surface and structural stability under the given test conditions as well as the type fracture which was obtained.

Steels Investigated

Table 1 gives the chemical composition, heat treatment and maximum permissible Brinell hardness of a series of 20 steels which have been subjected to stress-rupture tests over the temperature range of 900 to 1500° F. On the basis of composition these steels can be classified into the following four groups: silicon content below 0.50 percent, silicon content above 0.50 percent, aluminum-bearing steels and austenitic steels. In the first group the chromium content varies from 0.0 to 5.0 percent, in the second from 1.25 to 9.50 percent, and in the third from 3.0 to 5.0 percent. All of these are commercial production heats.

An explanation should be given for the choice of these particular steels. It is generally agreed that the corrosion resistance to hot petroleum products is proportional to the chromium content and consequently a wide range in this element should be considered since the required degree of corrosion resistance will differ greatly in the individual applications. Likewise, information now available[1] indi-

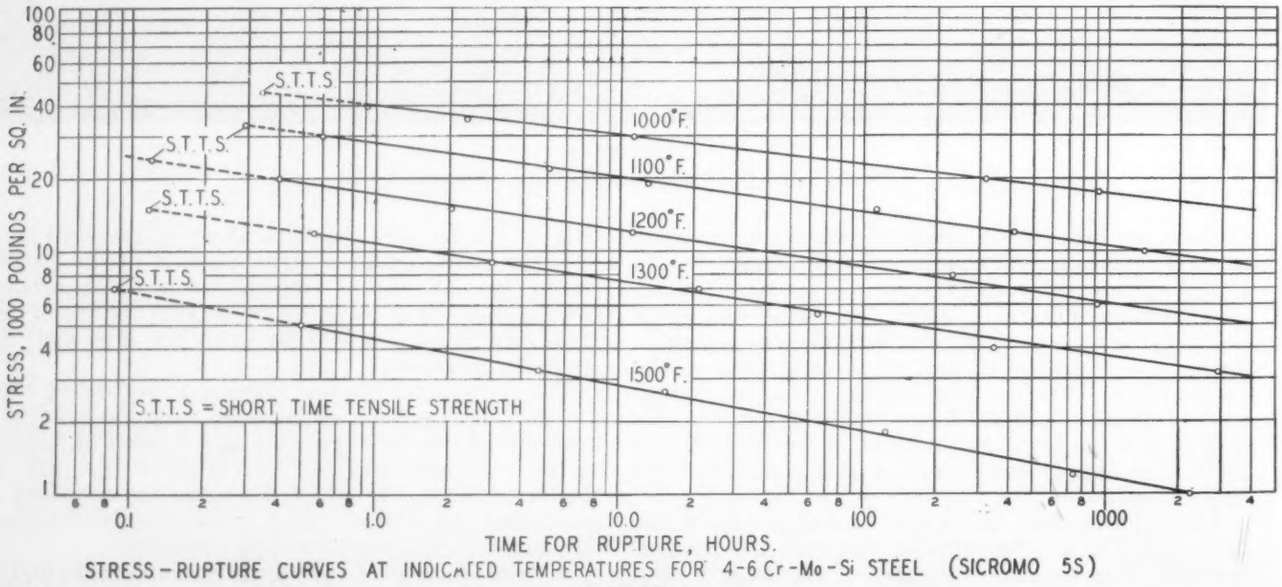
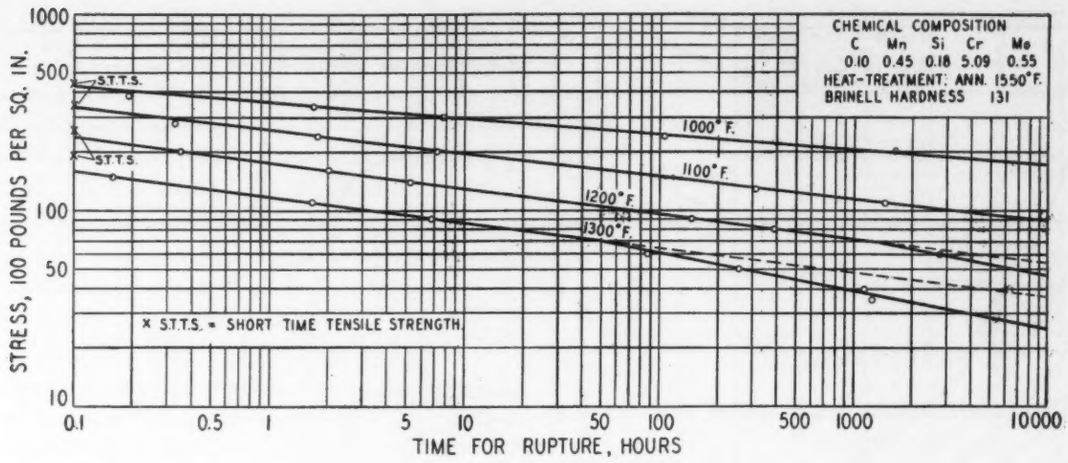


FIGURE 3



STRESS-RUPTURE CHARACTERISTICS AT INDICATED TEMPERATURES OF 4-6 Cr+Mo STEEL.

FIGURE 4

cates that this corrosion resistance is further improved by the addition of silicon or silicon plus aluminum. It has also been previously shown[2] that the resistance to oxidation can be considerably improved by an increased silicon content, or by the addition of silicon plus aluminum. In fact, as shown in Figure 6, silicon is seven times and aluminum four times as effective as chromium in this respect in chromium bearing steels. It follows therefore that the compositions given possess varying degrees of surface stability, both against corrosion in hot petroleum products and oxidation in air or combustion atmospheres.

Results

As previously indicated, results from the stress-rupture tests can be used to determine the load-carrying ability and the influence of time, temperature and stress on the hot ductility as well as on the surface and structural stability. A modification of this test can also be used in the rapid classification of steels of the same general type and as an acceptance test in the evaluation of high-temperature steels.

Load-Carrying Ability.

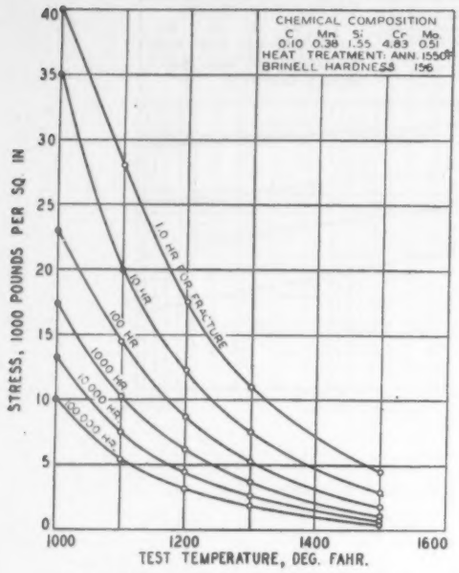
The load-carrying ability of 20 steels, based on stress-rupture tests, at temperatures ranging from 900 to 1500° F. are summarized in Table 2. Values are given for fracture time periods of 100,000 and 10,000 hours although if desired stresses for other time periods could be be readily determined. Table 2 likewise indicates whether a single straight-line logarithmic relationship existed between stress and fracture time or if a break occurred.

These values permit certain generalities to be drawn with respect to the influence of alloy additions

TABLE 1

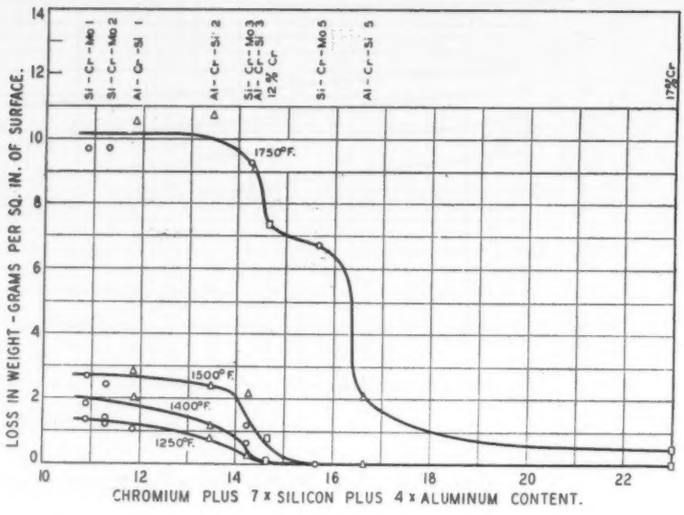
Chemical Composition, Heat Treatment and Brinell Hardness of Steels Subjected to Stress-Rupture Tests

Steel Designation	CHEMICAL COMPOSITION, PERCENT							Heat Treatment °F.	Maximum Brinell Hardness
	C	Mn	Si	Cr	Mo	Al	Ni		
Steels with Silicon Below 0.50 Percent									
1015	.15	.46	.28	....	....	....	....	Ann.	125
0.50 Mo	.13	.49	.25	....	.52	....	....	Ann.	150
DM-2	.10	.36	.25	.97	.55	....	....	Ann.	163
2¼ Cr. 1 Mo	.16	.39	.33	2.24	.90	....	....	Ann.	163
4-6 Cr. Mo	.10	.45	.18	5.09	.55	....	....	Ann.	163
Steels with Silicon in Excess of 0.50 Percent									
DM	.07	.42	.72	1.24	.54	....	....	Ann.	163
Sicromo 1	.15	.42	1.37	1.30	.54	....	....	Ann.	163
Sicromo 2	.09	.41	1.32	2.06	.51	....	....	Ann.	163
Sicromo 3	.12	.43	1.57	3.26	.50	....	....	Ann.	163
Sicromo 5	.11	.40	.93	5.24	.59	....	....	Ann.	163
Sicromo 5S	.10	.38	1.55	4.83	.51	....	....	Ann.	163
Sicromo 5M	.12	.39	.87	5.22	.99	....	....	Ann.	180
Sicromo 5MS	.10	.37	1.37	5.16	.89	....	....	Ann.	180
Sicromo 7	.11	.43	.92	7.33	.59	....	....	Nor. Temp.	180
Sicromo 7M	.11	.40	95	7.42	.99	....	....	Nor. Temp.	180
Sicromo 9	.10	.38	.65	8.74	.64	....	....	Nor. Temp.	180
Sicromo 9M	.12	.44	.67	9.50	.95	....	....	Nor. Temp.	180
Aluminum Bearing Steels									
Alcrosil 3	.12	.36	.90	3.02	.50	.52	....	Ann.	163
Alcrosil 5	.13	.42	.95	4.84	.51	.52	....	Nor. Temp.	163
Austenitic Steels									
18-8	.06	.50	.61	17.75	....	....	9.25	Quenched	200



STRESS REQUIRED FOR FRACTURE IN DESIGNATED TIME PERIODS FOR HIGH SILICON 4-6 Cr+ Mo STEEL

FIGURE 5


LOSS IN WEIGHT - GRAMS PER SQ. IN. OF SURFACE.
CHROMIUM PLUS 7 x SILICON PLUS 4 x ALUMINUM CONTENT.
Si - Cr - Mo 1
Si - Cr - Mo 2
Al - Cr - Si 1
Al - Cr - Si 2
Si - Cr - Mo 3
Al - Cr - Si 3
12 % Cr
Si - Cr - Mo 5
Al - Cr - Si 5
17%Cr
1750°F.
1500°F.
1400°F.
1250°F.

RELATIONSHIP BETWEEN OXIDATION RESISTANCE AND CHROMIUM PLUS 7 TIMES SILICON PLUS 4 TIMES ALUMINUM CONTENT.

FIGURE 6

TABLE 2

Stress-Rupture Characteristics of Designated Steels at Indicated Temperatures.

Steel Designation	Temperature, Degrees Fahrenheit					
	900	1000	1100	1200	1300	1500
Stress for Fracture in 100,000 Hours						
1015	.....	2,800*	.....	600*	420*	.....
0.50 Mo	.....	5,750*	.....	1,800*	525*	.....
DM-2	.....	24,500*	4,500*	1,700*	.....	.....
2¼ Cr. 1 Mo	.....	.....	.....	4,500	.....	.....
4-6 Cr. Mo	.....	14,500	6,700	3,000*	1,300*	105*
DM	.....	9,000*	.....	2,200*	700*	.....
Sicromo 1	34,000*	20,000*	5,200*	2,600*	.....	.....
Sicromo 2	23,000	11,750	4,400*	2,800*	.....	.....
Sicromo 3	.....	11,250	5,000	3,400	1,950	270*
Sicromo 5	.....	.....	5,400	1,600*	990*	330*
Sicromo 5S	.....	10,000	5,400	3,150	1,850	470
Sicromo 5M	.....	.....	7,000	4,700	2,300	220*
Sicromo 5MS	.....	.....	7,000	3,950	2,250	230*
Sicromo 7	.....	.....	8,400	3,600	1,700	250*
Sicromo 7M	.....	.....	10,000	4,600	2,200	380
Sicromo 9	.....	.....	6,800	1,450*	870*	270*
Sicromo 9M	.....	.....	11,800	4,600	1,600	420
Alcrosil 3	.....	13,000	6,900	3,900	1,700*	110*
Alcrosil 5	.....	13,000	5,800	3,150	1,050*	230*
18-8	.....	.....	.....	6,800*	3,700*	1,700*
Stress for Fracture in 10,000 Hours						
1015	.....	6,800*	.....	1,220*	780*	.....
0.50 Mo	.....	12,250*	.....	3,000*	1,100*	.....
DM-2	.....	30,500*	7,800*	3,100*	.....	.....
2¼ Cr. 1 Mo	.....	.....	.....	6,200	.....	.....
4-6 Cr. Mo	.....	17,250	8,900	4,700*	2,200*	280*
DM	.....	20,400*	.....	3,950*	1,400*	.....
Sicromo 1	39,000*	24,000*	7,900*	4,000*	.....	.....
Sicromo 2	27,000	15,000	7,000*	4,250*	.....	.....
Sicromo 3	.....	14,800	7,300	4,700	2,800	600*
Sicromo 5	.....	.....	7,600	3,000*	1,850*	580*
Sicromo 5S	.....	13,200	7,500	4,400	2,650	740
Sicromo 5M	.....	.....	9,400	6,200	3,300	440*
Sicromo 5MS	.....	.....	9,200	5,400	3,100	440*
Sicromo 7	.....	.....	10,750	5,100	2,600	500*
Sicromo 7M	.....	.....	12,500	6,200	3,250	660
Sicromo 9	.....	.....	9,400	2.850*	1,700*	530*
Sicromo 9M	.....	.....	14,500	6,200	2,500	700
Alcrosil 3	.....	17,000	9,300	5,400	2,600*	280*
Alcrosil 5	.....	16,000	7,800	4,400	1,850*	500*
18-8	.....	.....	.....	9,800*	5,800*	2,600*

* Break occurs in the logarithmic stress-rupture relationship.

on the high-temperature strength. For example, the strength does not increase continuously with increasing chromium content in either of the three types of steels. In fact at most temperatures the strength decreases as the chromium content exceeds a certain amount. In the majority of cases the strength is improved by an increase in the molybdenum content from 0.50 to 1.0 percent. Likewise the strength at the more elevated temperatures is raised by an increase in the silicon content due to the greater surface stability of the resulting steels.

Further evidence is thus offered to the fact that the higher alloyed steels do not necessarily possess the greater high-temperature load-carrying ability under the given test conditions, which in our work were oxidizing since the tests were conducted in air. However, strength, in itself, is meaningless unless proper consideration is also given to the degree of surface stability required for the given applications. Under more severely oxidizing conditions, such as encountered in combustion atmospheres, or in the presence of highly corrosive media, as in the refining of very sour crudes, the higher-alloy steels would show to greater advantage. Thus the use of the higher-alloy steels in many applications is not only justified, but necessary.

Stress-rupture results, when presented as in Figure 5, show the behavior of a steel under overheated, and thus overstressed, conditions. If a working fibre stress of 3000 pounds be assumed, then 100,000 hours would be required for fracture at 1200° F. As the temperature rose during service, however, fracture would occur in 10,000 hours at 1275° F., in 1000 hours at 1340° F. and in 100 hours at 1415° F. In this discussion no allowance has been made for safety factors or for the possible differences in behavior of a steel under simple tensile and tri-axial stresses.

The question often has been raised as to whether a relationship exists between the load-carrying ability, as revealed by the stress-rupture tests, and that obtained from other tests. The results of a correlation of rupture strength, creep strength and tensile strength are summarized in Table 3. From this it follows that the relationship between rupture

strength and creep strength varies with the composition but is in general independent of the temperature, while the relationship between rupture strength and tensile strength varies with both the temperature and the composition.

Hot Ductility Up to Fracture.

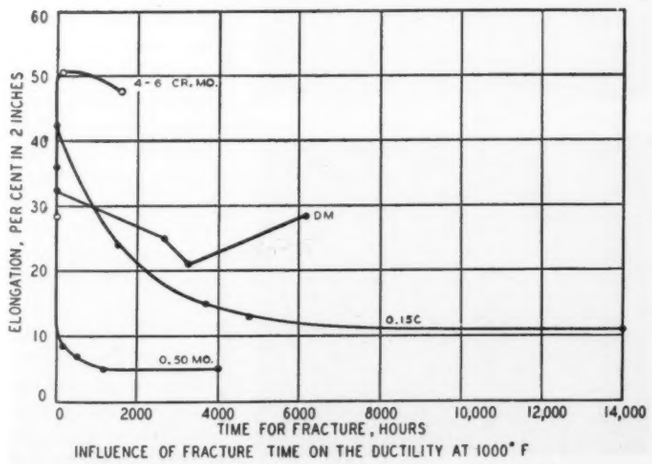
One of the chief merits of the stress-rupture test is its ability to show the influence of time, temperature and stress on the hot ductility up to fracture. Information of this type is believed to be of vital importance in order to insure against brittle type fractures in service. Yet no other high-temperature test reveals the ductility characteristics to be expected when failure occurs over a prolonged time period.

Steels differ widely in their ability to retain a high degree of ductility under the combined influence of time and stress. Not only does this depend upon the composition but on the temperature as well. The media to which the steel is subjected during service is likewise believed to be an important factor but little information is as yet available in this respect.

Figures 7 and 8 are included to illustrate typical differences which may exist in the hot ductility characteristics of steels when fracture occurs over prolonged time periods. From Figure 7 it is apparent that at 1000° F. and under the given test conditions, both plain carbon and 0.50 percent molybdenum steel lose their ductility at a rapid rate as the time for fracture is extended. In fact the elongation of plain carbon steel after a fracture time of 14,000 hours is only 11.0 percent while that of 0.50 Mo steel is only 5.0 percent after 4000 hours. On the other hand, DM and 4-6 Cr.Mo. retain a good degree of ductility at 1000° F. under the same test conditions.

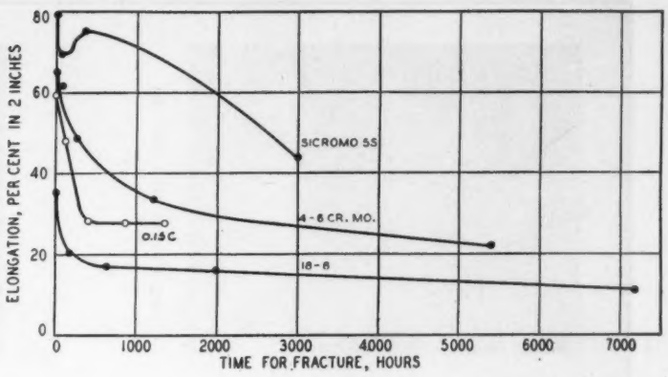
Likewise at 1300° F., Figure 8, 18-8 loses its ductility at a rapid rate, its elongation value after 7200 hours being 11.0 percent. While 4-6 Cr.Mo. retained a high degree of ductility at 1000° F., its ductility at 1300° F. decreases relatively rapidly. However, plain carbon steel retains its ductility better at 1300° F. than at 1000° F.

It can, of course, be argued that these values were obtained under overstressed conditions and that under normal operating stresses the ductility would not be influenced. No information is as yet available to support this belief and it hardly seems likely that a reversal in trends is to be expected. For example, in the case of plain carbon steel at 1000° F., Figure 7 shows the ductility to decrease continuously as the



INFLUENCE OF FRACTURE TIME ON THE DUCTILITY AT 1000° F

FIGURE 7



INFLUENCE OF FRACTURE TIME ON THE DUCTILITY AT 1300° F

FIGURE 8

fracture time period is extended up to 14,000 hours, or as the stress is reduced from 36,500 down to 6000 pounds. No basis exists for assuming that the ductility would again increase if the fracture time were further extended. Furthermore, commercial failures of the brittle type have occurred in plain carbon, 0.50 Mo and 18-8 steels and these lend support to the results obtained from the stress-rupture tests.

In the following section, explanations will be advanced to account for the loss of ductility in certain steels and the retention of a high degree of ductility in others.

Surface and Structural Stability.

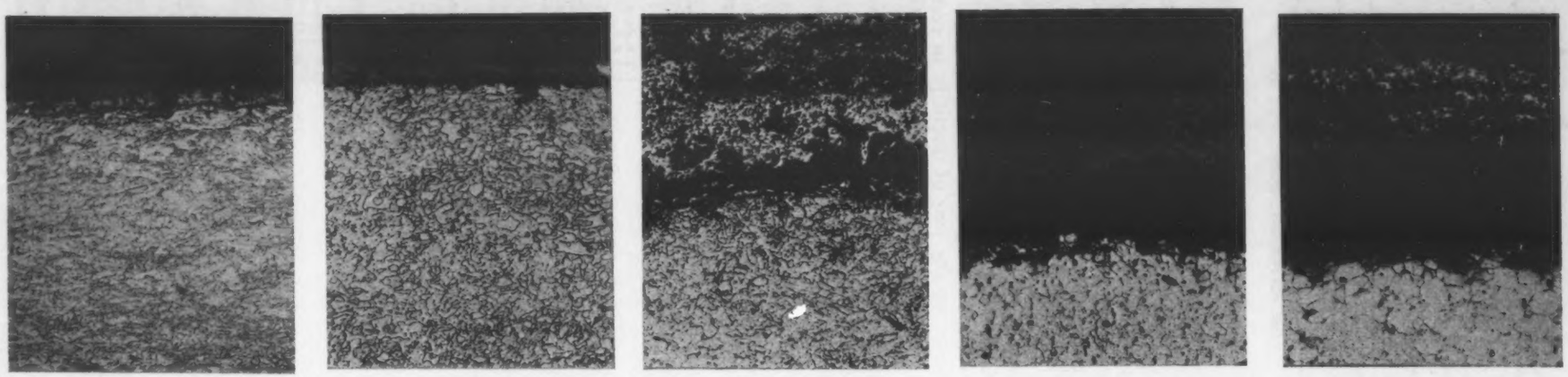
The stress-rupture test likewise provides a convenient and easy method for determining the relative

TABLE 3

Factors for Converting Rupture Strength (100,000 Hr.) to Creep Strength (0.01%) and Tensile Strength to Rupture Strength (100,000 Hr.)

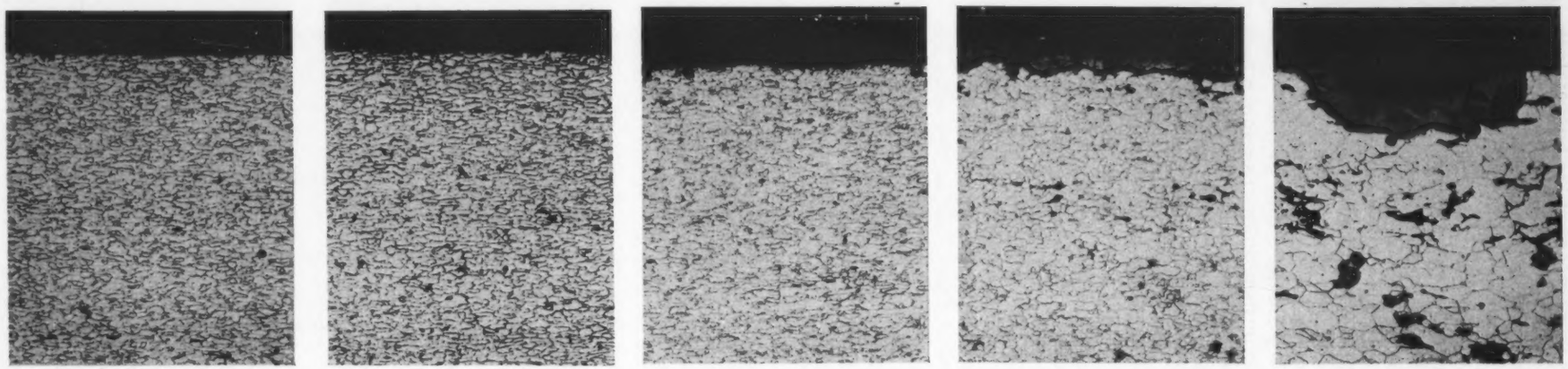
I. Rupture Strength (100,000 Hours) to Creep Strength (0.01%).	
A. Steels with Cr. in excess of 1.5%.	
1. 2 to 6% Cr., 0.50 Mo., 0-1.5 Si.	1/2 R.S.=C.S.
2. 2 Cr., 1.0 Mo., 0.50 Max. Si.	1/2 R.S.=C.S.
3. Al. bearing steels	2/5 R.S.=C.S.
4. Steels with 1.0 Mo.	
a. 3 to 6% Cr.	1/3 R.S.=C.S.
b. 6 to 8% Cr.	1/4 R.S.=C.S.
c. 8 to 10% Cr.	1/5 R.S.=C.S.
5. 6 to 10% Cr., 0.50 or 1.0 Mo.	
a. 6 to 8% Cr.	1/5 R.S.=C.S.
b. 8 to 10% Cr. at 1100° F.	1/5 R.S.=C.S.
at 1200 and 1300° F.	1/2 R.S.=C.S.
B. Steels with 0.0 to 1.5% Cr.	
1. Each analysis must almost be considered separately due to differences in their strain hardening characteristics, and surface and structural stability.	
II. Tensile Strength to Rupture Strength (100,000 Hours).	
A. At 900° F.	
1. Both steels	48% T.S.=R.S.
B. At 1000° F.	
1. 2 to 10% Cr.	25% T.S.=R.S
2. 0.5 to 1.5% Cr.	40% T.S.=R.S.
3. Cr. free steels	10% T.S.=R.S.
C. At 1100° F.	
1. 4 to 10% Cr.	20% T.S.=R.S.
2. 0 to 3.5% Cr.	12% T.S.=R.S.
D. At 1200° F.	
1. 2 to 10% Cr.	13% T.S.=R.S.
2. 0 to 2% Cr.	6% T.S.=R.S.
E. At 1300° F.	
1. 0-1.5% Cr.	3% T.S.=R.S.
2. 3-6% Cr., 1.0 Mo.	12% T.S.=R.S.
3. 6.5-10% Cr., 1.0 Mo.	8% T.S.=R.S.
4. 2-10% Cr., 0.5 Mo., 1.0 Si. Min.	12% T.S.=R.S.
5. 2-10% Cr., 0.5 Mo., 1.0 Si. Max.	7% T.S.=R.S.
F. At 1500° F.	
1. All steels	4% T.S.=R.S.

R.S.=Rupture Strength (100,000 Hours).
C.S.=Creep Strength (0.01%/1000 Hours).
T.S.=Tensile Strength at given Temperatures.



1000°F.—1600 Hr.—20,000 lbs. | 1100°F.—1425 Hr.—11,000 lbs. | 1200°F.—2710 Hr.—6000 lbs. | 1300°F.—5394 Hr.—2400 lbs. | 1500°F.—890 Hr.—700 lbs.

(a) 4-6 Cr. Mo. with 0.18 Percent Silicon.



1000°F.—930 Hr.—17,500 lbs. | 1100°F.—1044 Hr.—10,000 lbs. | 1200°F.—927 Hr.—6000 lbs. | 1300°F.—2987 Hr.—3200 lbs. | 1500°F.—2268 Hr.—1000 lbs.

(b) 4-6 Cr. Mo. with 1.50 Percent Silicon.

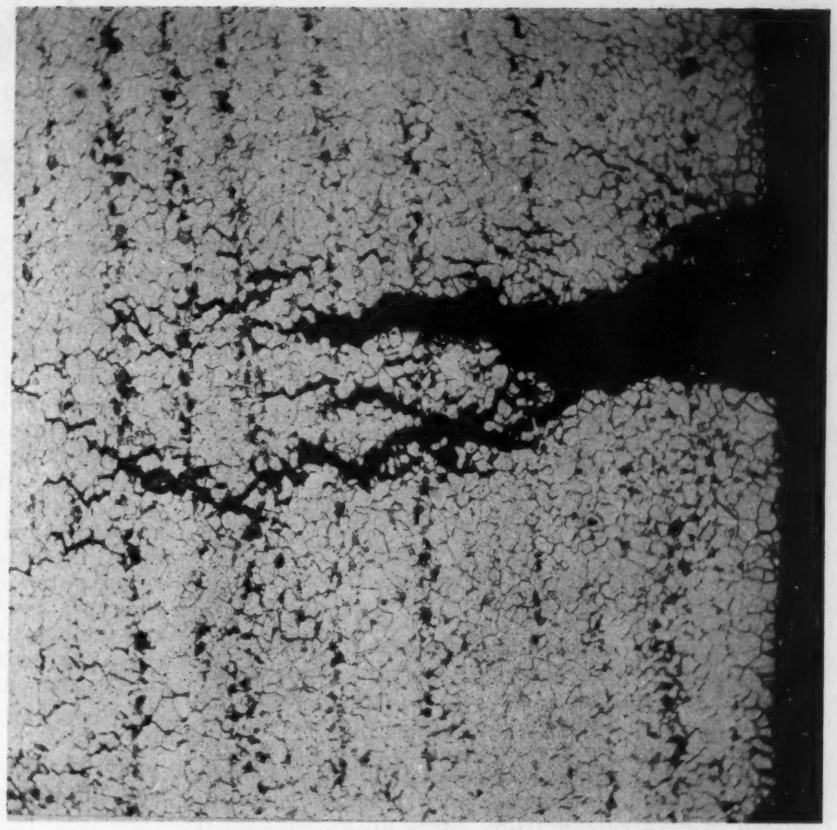
FIGURE 9
Influence of Time, Temperature and Stress (Rupture Tests) on the Surface and Structural Stability of Two Steels of the 4-6 Cr. Mo. Type—X100

degree of surface and structural stability under the given test conditions. If the steel possesses sufficient stability then a single straight-line logarithmic relationship will exist between stress and fracture time as shown in Figure 3. If, on the other hand, the steel is lacking in either type of stability, then a break will occur in the logarithmic relationship as demonstrated in Figure 4. A metallographic examination of the more prolonged fracture specimens will indicate the type stability in which the steel is lacking.

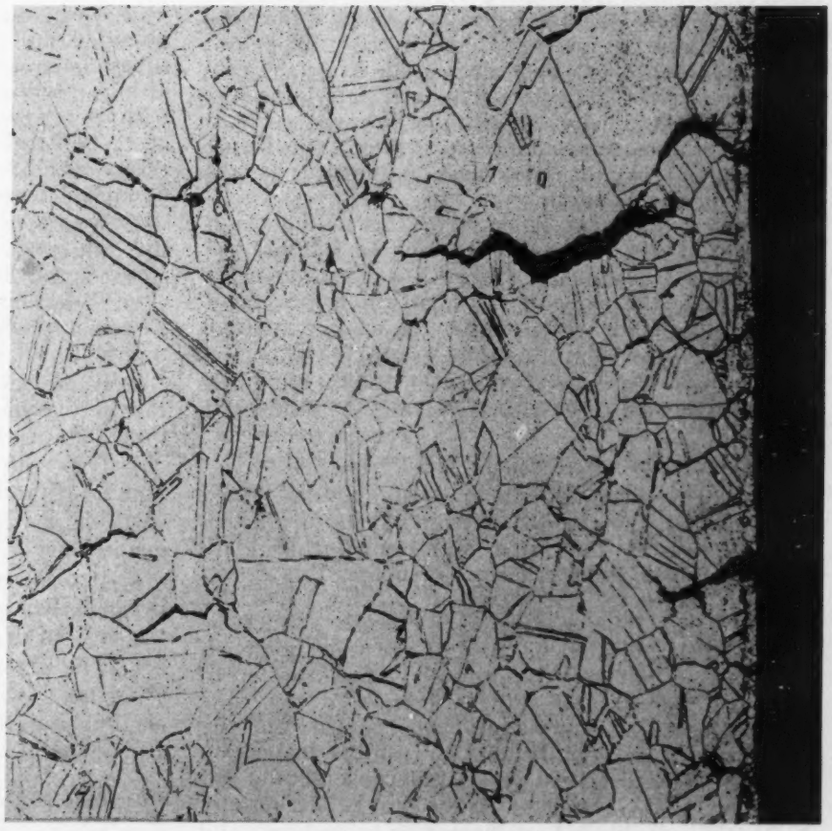
It again should be emphasized that all of the present results were obtained under relatively mild oxidizing conditions and any statements made with respect to surface stability apply to this condition. Under more highly oxidizing conditions, or in the presence of severe corrosion, the degree of surface stability might be reduced. The stress-rupture test readily adapts itself to these more severe conditions but no tests of this type have as yet been conducted in our laboratories.

Figure 9 shows the microstructures at the surface of the more prolonged rupture specimens of the two steels considered in Figures 3 and 4. In Figure 3 no break occurred at any temperature in the logarithmic straight-line relationship of the high silicon 4-6 Cr. Mo. steel and the micro-examination shows this steel to possess a high degree of surface and structural stability at temperatures up to and including 1300° F. At 1500° F. some grain coarsening occurred but this was not sufficient to destroy the original relationship. On the other hand, the lower silicon 4-6 Cr. Mo. steel, Figure 4, did show a break in its relationship at temperatures of 1200° F. and higher and the microstructures show this steel to possess a low degree of surface stability against oxidation at these temperatures.

A low resistance to general oxidation does not necessarily imply that the ductility will be decreased with increasing fracture times. If, however, the oxidation is of the intergranular type, or if excessive intergranular cracking occurs, then the ductility will be greatly decreased as the time for fracture is extended. For example Figure 10 shows intergranular cracking and oxidation in the 0.15 C steel specimen which required 13,950 hours for fracture at 1000° F. and intergranular cracking in the 18-8 specimen which fractured at 1300° F. after



(a) 0.15 Carbon Steel—1000° F.-13,950 Hr.-6000 lb.



(b) 18 Cr-8 Ni Steel—1300° F.-1978 Hr.-8000 lb.

FIGURE 10
Examples of Excessive Intercrystalline Oxidation and Cracking Under the Combined Influence of Temperature, Time and Stress—X100.

1978 hours. The elongations up to fracture of these specimens were 11.0 and 16.0 percent, respectively. Excessive intergranular attack likewise occurs in 0.50 Mo. steel at 950, 1000 and 1100° F.

As a standard procedure the more prolonged rupture specimens of each steel at each temperature are subjected to a metallographic examination, both at the fracture and at a section removed from it, and these have all been presented in a recent publication.[3] Those given in Figures 9 and 10 are believed sufficient to demonstrate the value of this examination in revealing the influence of time, temperature and stress on the stability characteristics.

Rapid Classification of Steels.

When the stress-rupture characteristics of a given steel have once been completely established, it is felt that this test provides a relatively short and convenient means for determining the comparative high-temperature load-carrying ability of other steels of the same general type. This is especially true when it is known that the proposed modifications in composition or heat treatment will not appreciably influence the relative degree of surface or structural stability.

For example, suppose it is desired to investigate the influence of increased molybdenum additions on the strength characteristics of the higher-silicon 4-6 Cr. Mo. steel of Figure 3. The stress-rupture characteristics of this steel have been completely established over the temperature range of 1000 to 1500° F. and a high degree of surface and structural stability existed at each temperature. Tests up to 200 to 300 hours could be conducted on the various modifications and if the resulting logarithmic lines lie above those of Figure 3 it is logical to assume that the strength has been increased, and if they fall below, that the strength has been decreased. After the outstanding steel of the series has been determined by this method, it is believed desirable to repeat at least certain of the more prolonged tests in order to insure that the stability has not been influenced by the changes in composition.

In the classification of steels by this method, it is suggested that at least 3 specimens be fractured at time periods of about 2, 15 and 250 hours in order to determine the slope of the logarithmic line. This is advisable since certain changes in composition may change this slope. In other words, the degree of change in strength may vary depending upon the deformation rate, that is, the time required for fracture.

High Temperature Acceptance Test.

A need exists for a simple and rapid method which will show whether or not different heats of a given analysis possess the same high-temperature load-carrying ability and furthermore whether this agrees with the characteristics claimed for this particular type of steel. The prolonged-creep test cannot be used for this purpose, because of the time involved, and likewise many of the proposed short-time creep tests are not suitable either because of the time involved or because the equipment required and the procedure is too complicated for routine inspection purposes. The ideal test for this purpose should not take over a day for completion, should not require the use of complicated equipment or procedures, and should yield results which are open to the least posssible question.

After the stress-rupture characteristics of a given steel have once been completely established over the desired temperature range, it is believed that a short-time rupture test of 5 to 8 hours provides a very suitable acceptance test. For example, it can be assumed that 10 heats of the higher-silicon 4-6 Cr. Mo. steel are to be investigated for their load-carrying ability at 1300° F. From Figure 3 it is apparent that the particular heat used for the prolonged stress-rupture tests would be very suitable for the intended service. It is further observed that with this particular heat a stress of 8000 pounds would require a fracture time of 7.0 hours.

If specimens from each of the 10 additional heats likewise required about this same time for fracture, then it would appear to follow that their load-carrying ability at this temperature was also the same as that of the heat originally tested. At least the assurance that this was the case would be better established than though the acceptance was based on room-temperature physical properties or on other proposed short-time high-temperature tests. Furthermore, these tests could be completed in one day in either a standard tensile machine or in a simple dead-weight apparatus, and the only variables involved are temperature, stress and fracture time. Each of these can be closely calibrated and controlled during the testing period.

Conclusions

On the basis of the results presented it is believed that the stress-rupture test is very useful in the evaluation of steels for cracking tube service for:

1. It affords a more simple means of determining the load-carrying ability and the rates of deformation in the prolonged tests are more comparable to those obtained during actual bulging or fracture of still tubes under overheated, and thus overstressed, conditions. Moreover, extrapolations to longer time periods are more justified than in most other types of tests because of the definite relationship which exists and because the values themselves are more fixed, not being as dependent on testing conditions.

2. It affords a convenient means for determining the influence of time, temperature and stress on the surface and structural stability as well as on the overall ductility up to fracture. The atmosphere can be readily varied so as to determine the influence of this factor.

3. It indicates the degree to which a given steel can be overheated during service and the length of time this overheated condition can be maintained.

4. It permits, on the basis of tests of 200 to 300 hours, a rapid classification of the relative load-carrying ability of a series of steels of the same general type.

5. It may serve as an acceptability test in indicating whether or not a given heat of steel possesses the desired degree of load-carrying ability.

6. The stress-rupture tests, in combination with other tests, will, therefore, assist in more completely establishing the high-temperature characteristics of a given steel.

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[3] "Digest of Steels for High Temperature Service." Fourth Edition, 1939, The Timken Roller Bearing Company, Steel and Tube Division.

Practical Water Conditioning For Industrial Purposes

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WATER treating is a term used by many persons and concerns to cover a wide field of useful or charlatanic efforts. There are no great deep and dark mysteries involved in the proper treating of waters but much has been written and advertised leading one to incline toward this belief. Water conditioning in its ramifications is just like any other science, if one is experienced or has available the assistance of persons acquainted with proper procedures there is no mystery to it and the problems resolve themselves to merely routine operations. When one mentions "water for industrial purposes" a large field is automatically surveyed, but for the purpose of relative brevity and clarity this discussion will apply more especially to refining and natural gasoline manufacture.

Indeed fortunate is the organization that has access to water that requires no treatment before use, either chemical or mechanical. Almost all waters, including extremely soft surface types, require some type of treatment before they can be used to their utmost efficacy. Some need to be zeolite, lime, or lime-soda softened, others to be treated for excess oxygen or hydrogen sulfide and others to be clarified and settled before use. Sometimes it is necessary to perform more than one operation on a water in order to render it fit for use. Also the treatment may be more or less elaborate, depending upon the use to which the water is put. For instance, it is more necessary to use a water of low solids content, especially encrusting, in boilers of high ratings and extreme pressures than in slowly fired low-pressure boilers. These differences will be brought out in the following discussions of the various types of treatments.

The two dominant uses for water in a refinery or gasoline plant are for boiler feed and for cooling water for condensers and coils. Either is vital to the operation of the plant and each, naturally, should receive its share of consideration. For the purpose of classification the various uses with types of treatment sub-headed are listed below, but not necessarily in order of importance.

Boiler-Feed Water:

1. Sedimentation and/or filtration.
2. De-aeration.
3. Zeolite softening.
4. Lime softening, with subsequent settling or filtration and possibly re-carbonation.
5. Lime-soda softening, either hot or cold process with subsequent settling and filtration.
6. After-treatment of any of the above with phosphate, sodium aluminate, tannin or other proprietary chemical or combination of chemicals.
7. Internal treatment of the water in the boiler by means of selected chemicals or combinations of same.

Plant Cooling-System Water:

1. Sedimentation.
2. Algae control.
3. Lime treatment.
4. Lime-soda treatment.
5. Colloidal agents to prevent scale encrustation.

Essential Properties

Water conditioned for boiler-feed purposes must have several distinct properties; freedom from oxygen that would oxidize the metal of the boilers and lines, freedom from encrusting salts that would form scale in boilers and feed lines, freedom from corrosive salts, freedom from suspended solids that would settle in boilers and lines probably causing stoppage or tube failures, and maintenance of excess alkalinity to care for traces of residual encrusting salts that enter the evaporative equipment.

Waters derived from cisterns and some surface supplies are sufficiently soft to be used directly in boilers without chemical treatment. However, they often are turbid or contain large quantities of dissolved oxygen. To eliminate the former the water must be either settled or filtered, sometimes both, depending on the density of the solids and their rate of settling. Settling usually is accomplished in earthen or concrete tanks or vats arranged in various combinations with various types of overflow weirs, or sludge removal systems. Where large quantities of water are to be handled special patented mechanisms are employed to accelerate settling. At times it is also necessary to add chemicals to facilitate the settling, these may be the sulfates of iron or aluminum or sodium aluminate.

De-aeration usually is accomplished at elevated temperatures in conjunction with an alkaline treatment such as lime, lime-soda or caustic soda. De-aeration may also be accomplished in the cold or hot condition by means of the addition of some chemical capable of combining with the oxygen to form a stable compound that has no detrimental effect on the steam-generating system. This additive may be sodium sulfite or other oxygen-absorbing compound recommended by competent authority. Recently several organic compounds have been put forward to achieve this result.

Softening with Zeolite

Zeolite water softening is a popular and highly perfected method of conditioning boiler-feed water, however, it has its limitations and disadvantages as well as its advantages. Its basis of operation is the actual "swapping" of the scale-forming radicals of

the dissolved salts for those of sodium and potassium which are soluble in the softened water, but do not cause encrustation on the evaporative surfaces of the boiler. The active reagents of the zeolite process may be complex silicates of iron and/or aluminum, either natural "greensand" or synthetic materials manufactured especially for water-softening use. Ordinarily the synthetic sand has a much larger capacity for softening water than does the natural mineral. The natural mineral will soften from 1500 to 3000 grains per cubic foot, of calcium and/or magnesium hardness before regeneration whereas the synthetic has been developed to the point where capacities of 10,000 grains are not uncommon. By knowing the capacity of the particular sand in use and the hardness of the water being treated the life of the zeolite between regenerations may be closely figured and allowed for in the design of the softening plant for certain desired through-put capacities. Thus, a cubic foot of natural sand may soften 100 gallons of 30 gpg hardness water whereas the same amount of synthetic would have a through-put of 333 gallons of water. Water passed through active zeolite continues to maintain practically zero hardness, unless there is channeling through the sand bed, until it is nearly spent. When regeneration is necessary the unit is cut out of service, another lined up in its place and common salt brine passed through the former. The salt replaces the calcium and magnesium that was exchanged in the softening reactions and the scale forming salts flow away with the residual NaCl that remains from the regeneration. The zeolite bed is flushed with fresh water until the salt is washed from it at which time the bed is ready for re-use.

A glance at the reactions involved in zeolite softening will show that not all waters can be satisfactorily handled by this method of treatment unless some sort of auxiliary treatment also is used to control the alkalinity of the treated water from sources of high initial carbonate hardness. Sulfuric acid is most generally employed and it goes without saying that its addition must be observed and controlled with the utmost caution.

Below are the skeletal reactions of the various types of scale and corrosion-forming salts when brought into contact with active zeolite:

(1)	$Mg(HCO_3)_2$ Magnesium Bi-carbonate	+	2Na Sodium Radical	⟶	2 $NaHCO_3$ Sodium Bi-carbonate
(2)	$Ca(HCO_3)_2$ Calcium Bi-carbonate	+	2Na	⟶	2 $NaHCO_3$ Sodium Bi-carbonate
(3)	$CaSO_4$ calcium Sulfate	+	2Na	⟶	Na_2SO_4 Sodium Sulfate
(4)	$MgSO_4$ Magnesium Sulfate	+	2Na	⟶	Na_2SO_4 Sodium Sulfate
(5)	$CaCl_2$ Calcium Chloride	+	2Na	⟶	2NaCl Sodium Chloride
(6)	$MgCl_2$ Magnesium Chloride	+	2Na	⟶	2NaCl Sodium Chloride

It can be seen from reaction (1) and (2) that for each mol of calcium and magnesium bicarbonate existing in the hard water two mols of sodium bicarbonate are formed in the softened effluent. If the carbonate hardness of the hard water is not excessively high this offers no particular difficulty, but if the carbonate hardness is out of proportion to the non-carbonate hardness, especially the sulfate hardness, corrective means must be applied to the softened water to obtain the proper ASME caustic-sulfate ratio. As specified by ASME this ratio should be as follows for the various boiler pressures involved:

Gauge Pressure	Caustic Alkalinity	Sulfate
0-150 lbs.	1	1
150-250 lbs.	1	2
Over 250 lbs.	1	3

This means that for each pressure range used in steam generation there is a ratio between the caustic alkalinity and the sodium sulfate content that will protect the boiler plates and nozzles from "caustic embrittlement." In many normal waters the balance between carbonate and non-carbonate hardness produces a caustic-sulfate ratio that is well within the limits recommended, but in others it is necessary at times to add non-incrusting sulfate salts or sulfuric acid in closely controlled quantities.

To practically illustrate the foregoing discussion let's assume several water analyses and determine whether or not they can be most satisfactorily treated by means of zeolite.

	Gr/Gal as $CaCO_3$
Water "A"	
Total hardness	12
Phenolphthalein alkalinity	0
Methyl orange alkalinity (carbonate hardness)	8
Sulfate hardness	4
Soluble non-incrusting sulfates	0
Water "B"	
Total hardness	20
Ph. alkalinity	0
M. O. alkalinity	16
Ca and Mg chloride hardness	3
Sulfate hardness	1
Other soluble sulfates	0
Water "C"	
Total hardness	27.6
Ph. alkalinity	0.0
M. O. alkalinity	11.4
Sulfate hardness	6.1
Chloride hardness	10.1
Other soluble sulfates	0.0

In water "A," with a carbonate hardness of 8 gr/gal, and assuming 100 percent conversion to sodium hydroxide in the boiler the resulting caustic alkalinity would be 3.95 gr/gal. Also produced would be 2 mols of carbon dioxide per mol of original carbonate hardness. As we have assumed above, the remaining hardness of the untreated water is due to calcium and magnesium sulfate and these salts would convert to sodium sulfate mol for mol, producing 4.2 gr/gal in the treated water. To get the ASME ratio the sulfate content is divided by the caustic alkalinity to obtain 1.06, or a ratio just satisfactory for the operating range of pressures up to 150 psi. If a higher pressure is to be maintained on a boiler fed with this water some means of either reducing the alkalinity or increasing the non-incrusting sulfate salt must be employed. With complete zeolite softening there exists a fairly definite ratio between the carbonate hardness of the hard water and the alkalinity of the softened water. However, there are exceptions as brought out by King and Smith.[1] They show that the alkalinity and free CO_2 content of a zeolite-softened water change as the mineral spends its sodium zeolite content. They attribute this to the original carbonic acid present in the influent water. The examples they cite contained appreciable amounts of carbonic acid, namely 7 and 15 PPM reported as free CO_2.

Applying similar calculations to water "B" the sodium hydroxide alkalinity in the boiler would be

in the neighborhood of 7.9 gr/gal for each concentration. Likewise the sulfate content would be 1.044 gr/gal and the ratio would be .132 or about one eighth the value necessary for embrittlement protection up to 150 psi gauge operating pressure. To assure proper operating conditions it would be necessary to add some sulfate ion either before or after the softening. If sulfuric acid is used it may be added either before or after, whichever is more convenient. The main objection to adding the acid before softening is that free CO_2 is formed and unless the water is de-gassed considerable fluctuation may be noted in the effluent water alkalinities and CO_2 contents. By adding the acid before softening no reduction in duty is obtained for the softener as the calcium or magnesium bi-carbonate is merely replaced by the corresponding sulfate. If, in the example on water "B," sufficient acid was added to reduce the initial alkalinity by half or to 8 gr/gal (requires 1.2 pounds of 93 percent sulfuric acid per 1000 gallons of influent water), the resulting boiler alkalinity would be in the neighborhood of 3.97 gr/gal and the sulfate would be about 11.4 gr/gal. This gives a ratio of 2.86 which is sufficiently high for pressures up to 300 psi.

If conditions make it more convenient to use sodium sulfate as the additive this also may be added before or after softening. Probably the main objection to sodium sulfate is in its relatively high cost. A comparison between the salt and the acid based on factory quotations at this writing indicates that the ratio for equivalent SO_4 is 2.145 cents and 84 cents per pound respectively.

For ease in calculating whether or not a water is amenable to zeolite treatment for use in boilers the following summary is given. Carbonate hardness may be assumed to be all calcium and the formulae used accordingly.

$$\underset{\text{Mol. wt. } 162}{Ca(HCO_3)_2} + 2Na \longrightarrow \underset{168}{2\,NaHCO_3}$$

Upon hydrolysis in the boiler the $NaHCO_3$ becomes NaOH as follows:

$$\underset{\text{Mol. wt. } 84}{NaHCO_3} \longrightarrow \underset{40}{NaOH} + \underset{44}{CO_2}$$

Thus the evolution produes the following:

$$(\text{Carbonate hardness})\left(\frac{168}{162}\right)\left(\frac{40}{84}\right) = (\text{carbonate H.})\ (.493) = \text{gr/gal}$$

NaOH per one concentration in the boiler.

The sulfate hardness is broken down as:

$$\underset{136}{CaSO_4} + 2Na \longrightarrow \underset{142}{Na_2SO_4}\ \text{or}$$

$$(\text{Sulfate hardness})\left(\frac{142}{136}\right) = (\text{sulfate hardness})\ (1.044) = \text{gr/gal}$$

soluble sulfate per one concentration in boiler.

Substituting in the above expressions for water "C" will give (11.4) (.493) or 5.62 gr/gal NaOH, and (6.1) (1.044) or 6.37 gr/gal Na_2SO_4. ASME ratio is: 6.37 ÷ 5.62 or *1.13* (OK for up to 150 psi).

Before leaving the discussion of zeolite softening some mention should be made of the methods and means of regeneration. This may be effected by means of either potassium or sodium chloride but the potassium salt is excluded at the outset due to its high cost. Sodium chloride, one of the cheapest of commercial chemicals is merely dissolved in water and forced through the spent bed of zeolite to render it fit for further softening reactions. This contact may be made by pumping or forcing the brine into the zeolite container and allowing it to remain there for from 10 to 30 minutes, or by forcing it through the bed continuously until the mineral is brought back to full activity, the circulation time usually being regulated from past experience. Normal consumption of salt varies from .3 to .5 pound per thousand grains of hardness removed, or from 3 to 5 pounds consumption for each cubic foot of synthetic zeolite regenerated.

The outstanding advantages of zeolite softening are ease of operation, no sludge disposal problem and easily obtained practically zero hardness water. After discussion of lime and lime-soda softened waters comparative costs will be brought forth on the several types of water softening systems.

Softening With Lime

The discovery that lime would soften water was made many years ago, in fact, long before it was applied commercially and on a large scale. In 1766, when Cavendish discovered that lime would precipitate calcium and magnesium salts from solution, there was no demand for softened water and the discovery was not applied until 1800, in England. From then until 1900 the main development of the process took place in England and abroad, and it was not until the twentieth century that the process was applied in earnest in the Western hemisphere. The first installations were cold lime-treatment types usually employing mixing and subsequent settling. Filtration through sand and gravel was later employed and still later came special mechanical settlers, concentrators, clarifiers and improved types of filtering equipment, all of which are in use now.

The softening reactions with lime and/or soda ash will proceed in the cold but are very much accelerated if the water is heated, the increase in speed being about doubled for each 10 degree rise in temperature. Along with hastened reactions is the increased speed of settling of the precipitated sludge due to the reduced viscosity of the water at the higher temperatures. Whether to treat in the cold or hot phase should be governed by the use to which the treated water is put. If it is to be used for boiler feed it has to be heated eventually, so why not in the softener and secure the aforementioned advantages. If the water is to be used in circulating cooling water systems it probably would not be economical or feasible to heat the water, other than the heat already obtained from the condenser boxes and closed coolers.

Lime is the cheapest chemical obtainable with its importance and diversity of application. It may be obtained practically anywhere in the United States for rarely more than 1 cent per pound, often less. With this fact obtaining it is no wonder that so much water is treated with this chemical, either hydrate or oxide.

The reactions between lime and scale-forming constituents of hard water are as follows:

(1) $\underset{\text{Calcium Bi-carbonate}}{Ca(HCO_3)_2} + \underset{\text{Lime Hydrate}}{Ca(OH)_2} \longrightarrow \underset{\text{Calcium Carbonate}}{2\,CaCO_3} + 2H_2O$

(2) $\underset{\text{Magnesium Bi-carbonate}}{Mg(HCO_3)_2} + \underset{\text{Lime}}{Ca(OH)_2} \longrightarrow \underset{\text{Magnesium Carbonate}}{MgCO_3} + CaCO_3 + 2H_2O$

(3) $\underset{\text{Magnesium Sulfate}}{MgSO_4} + Ca(OH)_2 \longrightarrow \underset{\text{Magnesium Hydroxide}}{Mg(OH)_2} + CaSO_4$

(4) $\underset{\text{Magnesium Carbonate}}{MgCO_3} + Ca(OH)_2 \longrightarrow Mg(OH)_2 + CaCO_3$

(5) $\underset{\text{Magnesium Chloride}}{MgCl_2} + Ca(OH)_2 \longrightarrow Mg(OH)_2 + \underset{\text{Calcium Chloride}}{CaCl_2}$

From the above reactions it may be seen that lime

reacts with a number of the encrusting and corrosive salts of calcium and magnesium, but, it will be noted also that some of the end products of the reactions are themselves soluble, encrusting and corrosive. In the case of reaction (1) the lime does a complete job, in so far as it can, and the products of the reaction are insoluble calcium carbonate and water. This reaction actually lowers the total solids content of the treated water. Many waters contain calcium bicarbonate as the major constituent of their total hardness, hence merely contacting them with lime will effect a large reduction in the total hardness and solids content, provided, that is, the addition of the lime is closely controlled and some provision made for taking care of the residual carbonate hardness which, if a slight excess of lime is maintained in the treated water, may be as low as two grains per gallon.

In reaction (2) the products are soluble magnesium carbonate, insoluble calcium carbonate and water. Here the total solids content is reduced slightly and further treatment is necessary for the reduction of the residual hardness due to the magnesium carbonate. This reaction goes to completion in the presence of excess lime and reaction (4) indicates the mechanics of same. In reaction (3) soluble magnesium sulfate (Epsom salts) reacts with the lime to produce insoluble magnesium hydroxide and calcium sulfate which though not very soluble adds sufficient hardness to the water to render it unsuitable for boiler feed. Magnesium chloride is likewise reacted with lime to produce magnesium hydroxide which precipitates and calcium chloride which is extremely soluble. This latter salt possesses corrosive properties and should be removed by further treatment which will be discussed later.

To illustrate the extent of softening that lime will accomplish in a typical water we will apply it to water "C" described under the zeolite discussion. In addition to the analysis given for this water the following will be necessary for this explanation:

Calcium bicarbonate	11.4 gr/gal
Calcium sulfate	6.1 gr/gal
Calcium chloride	6.3 gr/gal
Magnesium chloride	3.8 gr/gal

The calcium bicarbonate, it will be noted, accounts for 41.3 percent of the total hardness and can be treated to equilibrium solubility with lime. The calcium sulfate will not be reacted upon by the lime but must be treated with soda ash. The 6.3 gr/gal of calcium chloride likewise must be treated with soda ash. The 3.8 gr/gal of magnesium chloride will react with lime and according to reaction (5) will precipitate magnesium hydroxide and form soluble calcium chloride which must be further treated with soda ash. Thus to summarize the softening effected with lime we have: 11.4 gr/gal of calcium bicarbonate removed, no calcium sulfate or chloride removed and 3.8 gr/gal magnesium chloride converted to 4.4 gr/gal calcium chloride, resulting in a final total hardness of approximately 17 gr/gal, including the hardness due to the solubility of the calcium carbonate. Therefore, a reduction in total hardness of 38.4 percent is obtained by proper treatment with lime alone. If this lime-treated water is to be used in tubular coolers, condenser boxes containing condenser sections or in the jackets of internal-combustion engines it should be re-carbonated to render the residual calcium carbonate less active. Also, according to Rice and Partridge[2] if 1.5 to 5 PPM hexametaphosphate is maintained in this type of water the calcium carbonate scale formation may be considerably lessened or prevented.

It is seldom that water for boiler-feed purposes is treated with lime alone as any appreciable calcium or magnesium salts remaining would either foul or corrode the boiler drums and tubes. Thus, incorporation of soda-ash (Na_2CO_3) in the treatment offers a satisfactory method of conditioning almost any water. For industrial applications the hot process is employed most generally as the water usually is desired hot before being fed to the boilers. Also, if exhaust steam is employed to supply the heat the steam condensed into the system supplies up to 9 percent of the make-up water.

Lime-Soda Treatment

There probably is no water that has its hardness consisting of salts of calcium, magnesium and iron that cannot be softened by a combined treatment of lime, soda-ash, sodium aluminate, or some type of phosphate. The sodium aluminate is almost always employed in the sludge settler to promote and facilitate rapid settling of the precipitates. Phosphate of some type is usually employed as an after-treatment in the boilers to clear up any remaining amounts of calcium that may come through the external softener. Calcium phosphate apparently has the property of not baking onto the evaporative surfaces but is removed in the blowdown from the boiler. Usually a definite excess of dissolved phosphate is carried in the boiler water to accommodate any change in the amount of calcium entering. This amount usually ranges from 10 to 30 parts per million.

To supplement the reactions stated previously, the following are given below:

(6) $CaSO_4$ (Calcium Sulfate) + Na_2CO_3 (Soda Ash) $\longrightarrow$ $CaCO_3$ (Calcium Carbonate) + Na_2SO_4 (Sodium Sulfate)

(7) $CaCl_2$ (Calcium Chloride) + Na_2CO_3 (Soda Ash) $\longrightarrow$ $CaCO_3$ + 2NaCl (Salt)

With these two equations is completed the formation of insoluble calcium salts and non-incrusting sodium salts. The sodium sulfate formed aids in maintaining the ASME alkali-sulfate ratio and the NaCl formed merely increases the concentration of non-incrusting solids in the boiler. The control point for holding the proper concentration in the boiler is the NaCl content of the boiler. This amount when divided by the NaCl in the feed water shows the number of concentrations being maintained in the boiler. The proper concentration to hold in any particular case varies considerably and must be adjusted to meet local conditions such as type of water in use, type and construction of boilers and personal ideas of the men in charge of the boilers. This last item is mentioned due to the fact that the boiler men usually are acquainted with local conditions and know when a certain water will foam or prime, as the case may be.

There is nothing new or novel about the lime-soda-ash treatment of water but for those relatively unacquainted with the workings of the usual type of system it will be pictured and described briefly. Any number of construction companies have standard plants designed for various through-puts of treated, settled and filtered water. With certain conditions of operation and through-put specified, guarantees are usually made as to the degree of treatment the unit will provide. However, it is not necessary to have a large amount of new, expensive equipment to properly cold- or hot-process treat with lime and

soda ash. In the crudest of set-ups the water may be placed in a tank, the lime and soda ash added and some method of stirring provided. The reactions are relatively slow in the cold but may be greatly hastened by heating the water with open steam bubbled into the mixing tank. The addition of one fourth pound of sodium aluminate per thousand gallons of water will also facilitate settling and obtaining a clear effluent. The sludge settles to the bottom of the tank and may be periodically flushed or cleaned out. The clear treated water may be drawn from the tank by means of an adjustable swing line so that no sediment is withdrawn with the water.

Figure 1 depicts a typical hot-process lime-soda softening system and may be assembled at very reasonable investment. The raw water enters the system from storage and flows through a meter and thence to the heater atop the sludge settler. Exhaust steam, stripped of oil from plant lubricators, enters also at the top of the settler below the raw water inlet to the heater where the two intermingle by flowing up through or over some type of baffle plates. The water is heated, the steam condensed and together they fall into the body of the settler at which point the mixture of lime, soda ash and sodium aluminate, all in dilute suspension, are added. Reactions begin immediately and as the mixture flows downwardly through the settler the sludge; i.e., calcium carbonate, magnesium hydroxide, any iron salts present and some of the formerly dissolved silica tend to settle out and collect in the bottom of the settler. From an inverted cone the treated soft water is forced through one or more non-siliceous filter beds to remove any precipitate that may be carried over from the settler. It is a good practice to carry a few, say up to 10, pounds per square inch pressure on the settler in order to keep the temperature above 210° F. The boiler-feed pump takes suction on the filters and forces the hot softened water to the boilers through insulated lines. Any phosphate added to the system may be added to the water as it comes from the filters to prevent encrustation of the feed lines with unstable calcium carbonate. Usually the amount of lime, soda-ash mixture added to the softener is proportioned automatically by a mechanism attached to the raw-water meter. This mechanism either operates a swing line in the chemical tank or a system whereby the chemicals are proportioned according to differential flow pressures.

Lime and Soda Ash Calculations

As in any other chemical process most satisfactory results are obtained from proper and close control of the reagents involved. The following empirical equations have been tried and used in actual practice and are as reliable as any the author has seen. In the usual soap determination of the hardness of water probably everyone who has had occasion to run this test has noticed that before the actual end point of the titration is reached there is usually a point at which the lather completely breaks down and will not reform, even with continued shaking unless more soap solution is added. This has been termed the magnesium end point and represents an important point in the following calculation for the amount of lime to be used in the softening. For these equations the following data concerning the water is needed: the magnesium end point abbreviated MEP, total hardness H, phenolphthalein alkalinity P and the methyl orange alkalinity MO, all reported in grains per U. S. gallon calcium carbonate.

Pounds of lime required per 1000 gallons water=.12(H—MEP+MO+.6)
Pounds of soda ash required per 1000 gallons water=.16(H—MO+3.0)

To illustrate the use of these equations apply them to water "C." Substituting in the lime formula; .12(27.6 — 21.6 + 11.4 + .6) or 2.16 pounds of hydrated lime per 1000 gallons or raw water. Substitution in the soda ash formula evolves into .16(27.6 — 11.4 + 3.0) or 3.07 pounds soda ash per 1000 gallons water.

If, during the operation of the softener, an unbal-

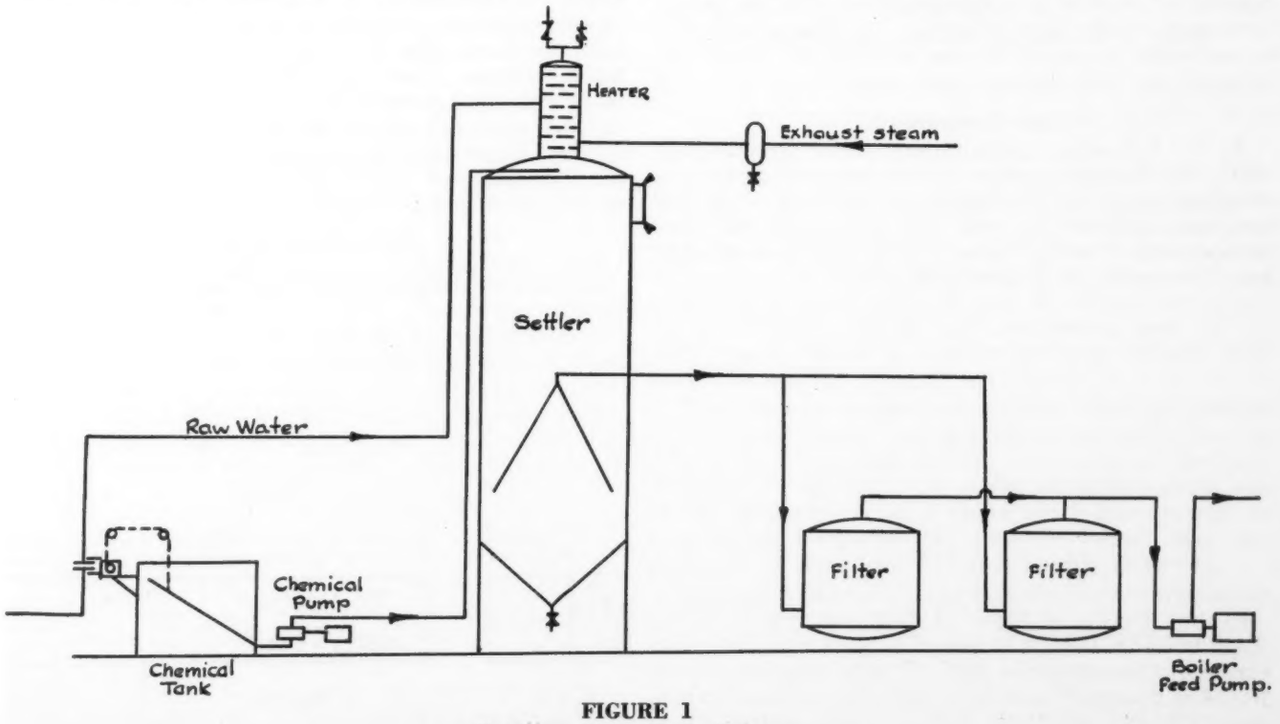

FIGURE 1
Hot Process Lime-Soda Softener

ance is obtained for some reason or other the following formulae may be applied for correction of the unbalance. These formulae apply only to the treated water.

2P—M equals lime excess or "L"	Should be .5 to 1.0 gr/gal
M—2P equals lime shortage "B"	
M—H equals soda ash alkalinity "S"	Should be 2.0 to 3.0 gr/gal
S—L equals soda ash excess "X"	Should be 2.0 to 4.0 gr/gal

If there is no L, then S is equal to X
L—S equals LL free lime or soda ash shortage
If there is no S then B equals LL

The following formulae are for the correction of the base charge based upon tests of the treated water. They may serve as a check on the accuracy of the calculations based on the raw water analysis.

.12 (B + .5) equals pounds lime increase per 1000 gallons raw water
.12 (L — .5) equals pounds lime decrease per 1000 gallons raw water
.16 (LL + 2.0) equals pounds soda ash increase per 1000 gallons raw water
.16 (S — 2.0) equals pounds soda ash decrease per 1000 gallons raw water

In all the above expressions the unknowns and constants are in terms of grains per United States gallon calcium carbonate. Reagents necessary for elementary routine examination are standard soap solution, standard acid and standard silver nitrate solutions. The standard soap solution may be purchased already standardized from any laboratory supply company and the other standard solutions may also be purchased or may be made up from the CP chemicals and distilled water. The standard acid solution should be 1/29.2 Normal when titrating 100 cc of sample. This strength contains 1.68 grams of 100 percent sulfuric acid per liter of solution or .95 cc of 96 percent acid per liter. This figure is closely approximate and will vary with the specific gravity and concentration of the CP sulfuric acid used but is sufficiently accurate for routine control tests. A suitable standard silver nitrate solution contains 7.285 grams of the CP salt per liter of solution. A 50 cc sample of the water is titrated and the number of cc of silver nitrate solution multiplied by 10 gives the chloride content in grains per gallon. The chloride titration should be carried out in a nearly neutral solution so as not to interfere with the proper formation of the lead chloride. An akaline solution is preferable to an acidic one and the pH should be adjusted so with sodium carbonate.

Cost Comparisons

As the following computations show the chemical costs for the two types of softening systems are identical using the average costs for lime, soda ash and rock salt of .75 cent, 1.60 cents and .75 cent respectively. The cost assumed for sodium aluminate was 7.00 cents per pound delivered.

Lime Soda System:

(2.16 lbs. lime per M gallons) (.75) is.....1.62 cents
(3.07 lbs. S.A. per M gallons) (1.60) is.....4.91 cents
(.25 lb. sodium alum/M gallons) (7.00) is....1.75 cents

Total chemical cost for 1000 gals softened....8.28 cents

Zeolite System:

$$\frac{\text{(27.6 gr/gal hardness) (1000 gals)}\ \text{(.4 lb. salt) (.75c/lb.)}}{\text{(1000 grains hardness removed)}} = \text{8.28c per 1000 gallons softened}$$

One may readily deduce from the above computations that a water high in temporary hardness, i.e., carbonate hardness, may be more cheaply treated with lime and soda ash than with zeolite, whereas conversely if a water is composed largely of magnesium and calcium sulfate and chloride hardness the zeolite treatment will be more favorable.

Internal Boiler Treatments

There are instances in which it is not feasible to install elaborate water softening equipment. In these cases internal treatment may be resorted to, using the boiler as the feed-water heater and sludge settler. It goes without saying that continual blowing down is imperative in order to keep the precipitated sludge from settling on the tubes and crown sheets of the boilers. Usually proprietary compounds are employed for this type of treatment, recommended by some reputable chemical or water service company experienced in such matters.

A mixture of caustic soda, soda ash or sodium phosphate and tannin is very effective as such an internal treatment. The mixture should be made up and preferably fed continuously at the point where the feed water line enters the boiler. The concentration of the boiler water should be closely watched and not allowed to get to the point where foaming and priming will take place. Alkalinities on the order of those carried in boilers fed with lime-soda-ash-softened water are acceptable and if the ASME caustic-sulfate ratio is watched and held within proper limits no particularly difficult situation should arise by internally treating waters up to 25 gr/gal total hardness. Continuous blow-down is preferable to intermittent blow-down when internally treating as this does not allow the sludge to settle in the drums. However, intermittent blow-downs should also be employed to periodically rid the bottom drum of any localized accumulation of sludge.

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Steels for Low Temperature Service

WELDON L. ARCHER

UNTIL recently the most important low-temperature operation in petroleum refining was dewaxing. Here temperatures ranged as low as —75° F. Now, low-temperature recycling has entered the picture with temperatures below 0° F. So proper selection of low-temperature material is of more than academic interest.

Ordinarily when tensile strength and yield point of steels increase both elongation and reduction of area values (the ductility indices) decrease. As the temperature of steels is lowered both the tensile strength and the yield point become greater. But the lowering of the ductility figures is less than would be expected. And all the physical properties of steel are satisfactory as temperatures become lower with one outstanding exception: the impact strength. At low temperatures steel is embrittled.

At this point the refiner may want to ask the logical question, "So what?" For the importance of impact strength at low temperatures in the operation of pressure vessels is open to question. In fact Mr. E. E. Thum asked such a question at the 1939 annual meeting of the American Society for Metals. And the reply by Messrs. Armstrong and Gagnebin is important enough to be quoted:

"In answer to questions raised by Mr. Thum, there have been failures in oil refineries directly traceable to materials having low impact resistance at sub-zero temperatures. As to how much extra cost is justified for high impact properties, it depends not only upon replacement cost but extent of damage such failures might incur. If a fire results, which has happened in refineries because of such failures, the extra cost for materials of high impact strength will be only a few hundredths of a percent of the cost of the damage."

That statement indicates a need for proper attention to the selection of material for processes operating at temperatures below zero. For temperatures down to —100° F. it is possible to use unalloyed steels that have been made with due attention to their ultimate service conditions. For temperatures of —50° F. to —150° F. the best solution appears to be the use of steel alloyed with nickel. The overlapping of temperatures is not an accident. Nickel steel is so outstanding in this temperature range that a slight extra cost may be warranted. And, finally, for temperatures below —150° F. the use of an austenitic stainless steel, such as 18-8, may best suit the conditions.

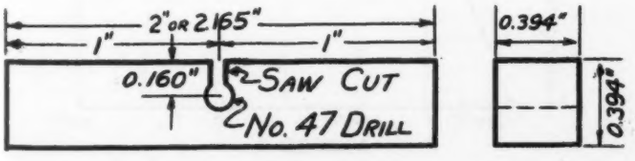

FIGURE 1
Charpy Notched Impact Specimen—Keyhole Notch

Measuring Embrittlement

Embrittlement of steel at low temperatures is measured by means of Charpy impact specimens. Figure 1 shows the standard keyhole notch specimen. Unfortunately this specimen leads to a scattering of data that does not occur with the V-notch Charpy specimen illustrated in Figure 2. But most specifications use the keyhole notch and data for this type of notch must be presented as well as that for the more consistent V-notch.

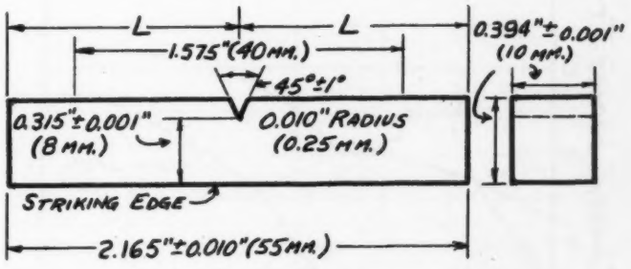

FIGURE 2
Charpy Notched Impact Specimen—Vee Notch

In the beginning of the application of nickel steels to low-temperature service the SAE 2315 steel was specified. At that time there was no ASTM designation for nickel steels and the Society of Automotive Engineers material containing 3.50 percent nickel with 0.15 percent carbon found widespread adoption. Now, however, ASTM-A203 containing from 2.00 to 2.75 percent nickel is used for pressure vessels with excellent results.

The effect of temperature on the impact properties of the steels under consideration is demonstrated in Figure 3. The divergence of the points of the data accounts for the two lines at the low-temperature side of the diagram. Since a value of 10 foot/pounds is considered adequate for pressure vessel use, the influence of the added nickel is readily observed.

Mention was made of the fact that low-temperature service down to —100° F. could be served with carbon steel. So it may. The use of ASTM A212-39 high-tensile-strength steel for this temperature range has proven satisfactory. The steel was discussed in detail in an earlier issue of THE REFINER AND NATURAL

TABLE 1

Percent					As Forged		Charpy Impact, Ft./Lbs.* Normalized 1 Hr. @ 1650° F.	
C	Ni	Mn	Si	Al	Room Temp.	—50° F.	Room Temp.	—50° F.
0.20	2.01	0.65	0.12	.....	79	26.5	80.5	22.5
0.19	2.14	0.66	0.12	0.04	75.5	62.5	75.5	56

* Vee Notch.

GASOLINE MANUFACTURER. For the method of manufacture of the steel has a profound influence on low temperature impact strength. Silicon killed steels, and ASTM A212-39 is silicon killed, work very well. But the carbon content of this material is liable to run 0.25 percent and more. Higher carbon has a detrimental effect on the low-temperature brittleness. And that explains why nickel steel is recommended for service temperatures below —50° F.

In addition to silicon a small amount of aluminum may be added to kill the steel. In this case an even greater resistance to impact is noted. The importance of the degree of deoxidation may be seen from the results in Table 1.

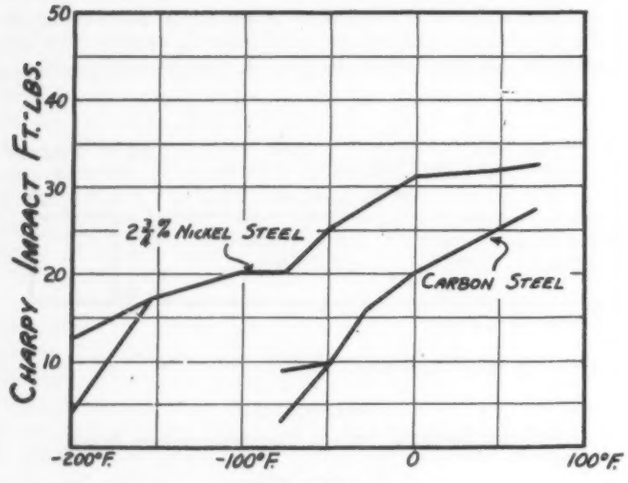

FIGURE 3
Keyhole Notch Charpy Impact Values for Nickel and Carbon Steels.

The influence of carbon on the impact strength of carbon steel may be observed in Figure 4. Very small increases in the amount of carbon exert a marked influence on the impact strength not only at —50° F. but also at room temperature. From this figure the importance of keeping the carbon as low as is practical may be learned. In addition where strength or hardness must be kept at a certain value the interrelationship between nickel and carbon must be taken into consideration. Table 2 points out the interchanging of carbon and nickel to maintain a specified hardness.

TABLE 2

BHN	Ni	C	Charpy Ft./Lbs. Rm. Temp.	(Vee Notch) —50° F.
150.....	0	0.33	25	5
150.....	1	0.22	85	20
150.....	2	0.16	95	43
150.....	3	0.12	110	70
150.....	4	0.04	172	170

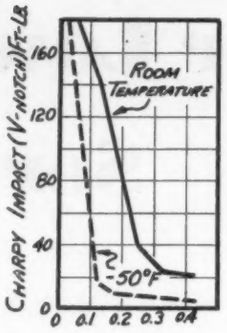

FIGURE 4
Effect of Carbon on Impact Properties of Carbon Steels.

Because of economic considerations no one would think of using nickel in place of carbon to attain a required strength condition beyond a certain point. Fortunately the ASTM specification for weldable nickel steel considers strength and low-temperature impact strength together to arrive at proportions that are sound from the cost viewpoint.

To prove this point, Figure 5 presents the low-temperature impact strengths of 3.50 percent and 2.00 percent nickel steels. Down to —150° F. there is little advantage to be gained by the use of the higher nickel alloy. Both steels exceed the limiting figure of 10 foot/pounds by a very comfortable margin. These materials were normalized, and drawn 0.16 percent carbon steel treated with 0.08 percent aluminum.

Many steels, particularly those greater than two inches in thickness, are normalized. The normalizing heat treatment of heating the steel to a point above its critical temperature and cooling in still air refines the grain. In sections lighter than two inches the working that takes place during the rolling operation is believed to refine the grain sufficiently. And steel with fine grain (there have been exceptions) possesses greater impact strength. Therefore normalizing may be specified as a further means to increasing the impact strength of steel.

How to Weld It

Up to this time the discussion has been limited to the selection of material for pressure vessels operating at subzero temperatures. Agreement should have been reached on the use of ASTM A212-39 or ordinary ASTM A70-39 suitably killed for temperatures to —50° F. From that temperature down to —150° F. nickel steel conforming to ASTM A203 appears to be the best choice. And below —150° F. sound engineering indicates the selection of 18-8 stainless steel.

How about the welding of these steels? Since the welding of stainless steels will be discussed later

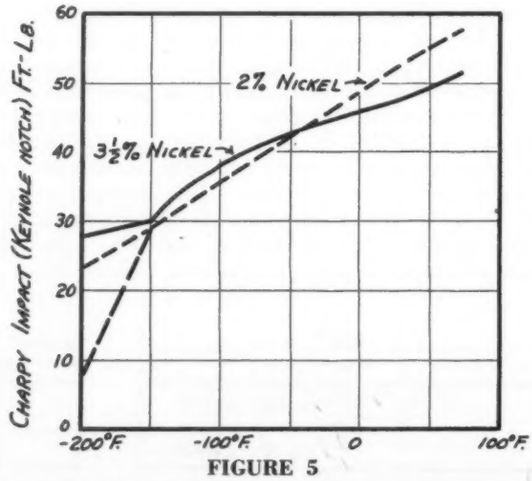

FIGURE 5
Effect of Nickel on Low-Temperature Impact Properties of Normalized and Drawn 0.16 Percent Carbon Steel Treated with 0.08 Percent Aluminum.

in this series and since the other steels have already been discussed, the nickel steels will be considered here.

In general there is no difficulty attached to the welding of nickel steels. The main precaution to be observed is the need for adequate heating. Wherever welding is attempted heat is one of the fundamental variables that demands attention. Most people are amazed at the possibilities of welding when coupled with the judicious use of supplementary heating.

Although preheating and postheating are important in connection with the welding of many steels other than nickel steel, these operations are extremely important in respect to the welding of nickel steel. Low-carbon steel should not offer any problems in welding. Nickel does not exert a strong hardening influence. Instead nickel is said to strengthen the carbon-free (substantially so) portion of the steel: the ferrite.

The low carbon and the non-hardening tendency of the nickel appear to work together to eliminate the need for additional heating. Yet those experienced in the welding of nickel steels are aware of the paradox that exists here. For nickel steel welds have been found lacking in ductility to an alarming extent when the interpass temperature was allowed to drop too far below 400° F.

Two simple methods of welding are suggested. Either preheat to 400° F. and arrange a heating setup that will supply this heat throughout the welding operation or weld by the block method. This latter method is liable to be unfamiliar. It is essentially a scheme of welding short section or blocks of the part to be welded. Thus the interpass temperature is kept high throughout the welding operation.

Wherever there is an abundance of cheap fuel for preheating and maintaining the heat, it is good practice arrange heating equipment to keep the joint hot at all times. The added fuel and jig expense will be more than offset by a lower cost of welding. As long as labor continues to be the most costly part of the welding operation, all effort should be pointed in the direction of keeping labor costs to a minimum.

Heating is necessary to prevent the formation of a hardened heat affected zone. Such a region is almost without any ductility whatsoever. Indeed it would be a doubtful gain to use nickel steel for improved impact strength at low temperatures only to weld that steel in such a fashion as to destroy its excellent ductility.

One word about the available electrodes is in order. To date there are heavily coated electrodes on the market that are well adapted to the welding of nickel steel. The nickel content of these electrodes is 2.25 percent which is ample. But there are no carbonaceous all-position electrodes such as are required for vertical and overhead welding.

With Molybdenum

Where piping must be welded in these positions, two courses of action are open. One is to use the heavily coated electrodes in such small diameters that the welding may be accomplished. If a nickel deposit is demanded, this procedure may be followed. In at least one large installation, it was. But it is too costly. Far better is the use of a carbonaceous all position electrode containing in the neighborhood of 0.5 percent of molybdenum.

Molybdenum improves the low-temperature impact strength to a slight extent. In fact the most severe services use nickel and molybdenum in combination. Then the low-carbon, averaging about 0.10 percent of the weld deposit is a good low-tempeature material. And remember nickel will be picked up from the base metal. So all in all the use of the faster all-position electrode will produce satisfactory results without a prohibitive expenditure for welding labor.

Lastly the physical properties of the weld metal and low-carbon nickel steel will be reported to complete the picture. Not all the properties of the steels are given as it is assumed that interest in the low-temperature impact strength is highest. These figures are given in Table 3.

TABLE 3

STEEL	Charpy Impact Ft./Lbs., Keyhole Notch			
	Room Temp.	—100° F.	—150° F.	—200° F.
Low C, 2¾ percent Ni.....	59, 60	37, 39	35, 37	23, 26
Weld metal, flat weld.....	33, 33	18, 23	14, 21	3, 3

With the exception of the values at —200° F. all of the impact strengths reported for the weld metal are well in excess of the 10 foot/pound minimum. Nor is exceptional skill demanded of the welding operator to attain such figures.

If the supervisor of welding makes certain that the weldment is preheated and kept hot during the course of the welding, any good welder will produce consistently fine weld metal. Stress-relieving is in order for nickel pressure vessels. Temperatures towards the higher end of the range give the best results, say 1150° F. to 1250° F. The regular holding time of one hour per inch of thickness will accomplish the purpose. If available, the use of radiographic examination of the welds will be another safeguard to insure the quality of the deposit.

Nickel steel is high-strength steel. When this factor is considered, the cost of obtaining a proper steel for low-temperature service is quite in line. Sound, rather than ultra-conservative, engineering practice advises the use of nickel steel wherever low temperatures are encountered in refinery practice.

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Propeller Pumps For Circulation of Molten Salt

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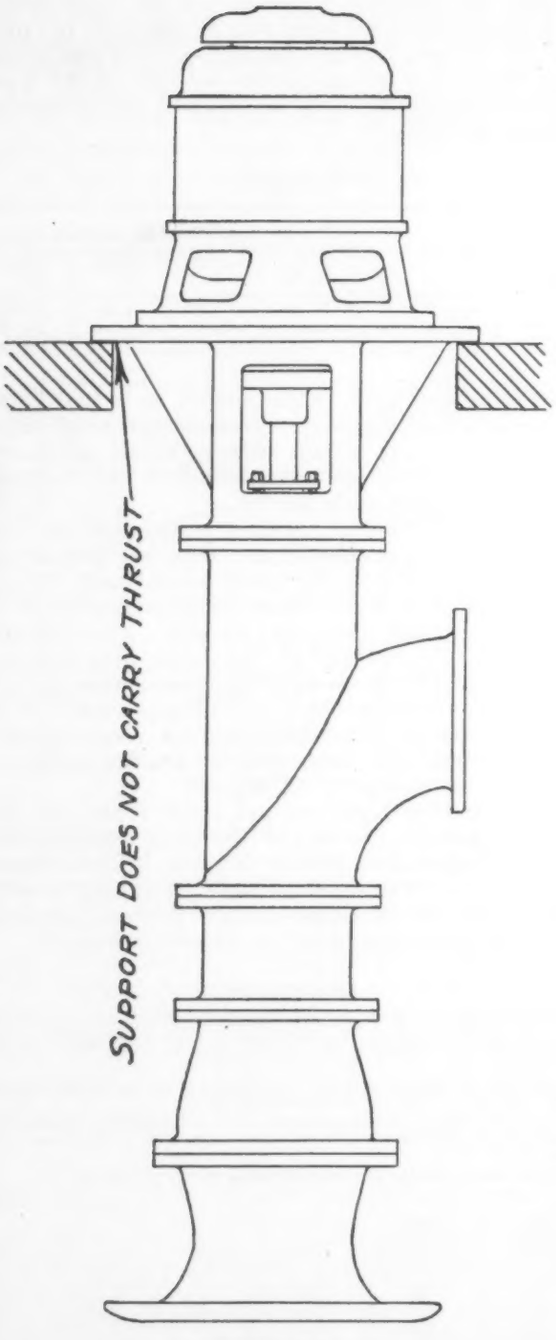

FIGURE 1
Vertical Propeller Pump

INTRODUCTION of catalytic cracking processes for petroleum-hydrocarbon refining requires a special type of pump new to the petroleum industry. First of all, the nature of the liquid is different from the various products of distillation handled heretofore with centrifugal pumps. In most general terms for the pumping problem the liquid can be described as a hot liquid of about 850° F. of specific gravity of 1.75, not boiling at atmospheric pressure. For brevity it will be referred to here as molten or hot salt. The amounts to be pumped are many times greater than ever before encountered in the refining practice—such as 17,000 G.P.M., while the heads against which the pumps have to operate are relatively low, being of the order of 45 feet.

These pumping requirements call for a propeller type of pump, although on some occasions types nearer to centrifugal rather than propeller type of pump have been employed. In general, pumps are arranged vertically, the pumping element proper being immersed in the hot salt to be pumped at atmospheric pressure. Motor as a rule is supported on a subbase which is a part of the pump discharge columns. In a certain modification of the process the liquid to be pumped is under vacuum.

The question of materials for various parts, particularly for internal bearings operated in the hot salt were finally satisfactorily settled after several trials on the experimental units.

Although hydraulically the pumping of hot salt of the above specifications does not present unusual difficulties, certain phases of it require special attention and have caused some disappointment, when not properly taken care of.

Cavitation

One of the serious problems encountered in pumping hot salt is the question of cavitation. Although in a certain process the hot salt is pumped from atmospheric pressure and submergence of several feet above the propeller is available, the behavior of the pump as to cavitation is entirely different from that when pumping water under similar suction conditions. The difference comes not from the high temperatures of the hot salt (as long as it is not boiling) but from the high specific gravity. The difference will probably be better revealed if a numerical example be taken.

Suppose a certain propeller pump is pumping water under atmospheric pressure and against a head of 45 feet. The propeller is submerged 6 feet

below the surface of the water. The majority of propeller pumps will work quite satisfactorily under these conditions. For comparison the suction conditions are described by a "cavitation factor" expressed as follows:

$$\sigma = \frac{32.5 + 6.0}{45.0} = 0.853 \qquad (1)$$

where the numerator is the absolute pressure at the pump impeller equal to the atmospheric pressure in feet of water, plus the submergence and less the water vapor pressure at pumping temperature; the denominator is the total pumping head in feet.

It has been proven that the pump behavior is similar if the cavitation factor is the same, irrespective of actual speed or head the pump is working, provided the operating point is similarly located in respect to the best efficiency point or that specific speed of the operating point is the same.

Evidently, if the same pump is pumping hot salt against the same head of 45 feet with atmospheric suction pressure and 6 feet submergence the cavitation factor will be quite different, because the atmospheric pressure is no longer equivalent to 34.0 feet, but to 33.0/1.75 = 18.85 feet; thus

$$\sigma = \frac{18.85 + 6.0}{45.0} = .552 \qquad (2)$$

To obtain identical suction conditions as in the first case, the submergence S is calculated to be S = 19.45 feet.

$$\sigma = \frac{18.85 + S}{45.0} = .853 \qquad (3)$$

Hence S = 19.45

Thus if only six feet submergence is available this can be compared with the case when pumping water under suction lift of 8.3 feet, corresponding to $\sigma = .552$.

$$\sigma = .552 = \frac{32.5 + S_1}{45.0}; \qquad (4)$$

and $S_1 = -8.3$, negative sign indicating that it is lift, and not submergence.

When pumping hot salt from a vacuum suction conditions can be checked in a similar manner by comparing values of the cavitation constant σ. The higher the vacuum the less will be the effect of specific gravity on submergence as compared with that when pumping water.

Hydraulic Thrust

Another problem arises when pumping hot salt resulting from the effect of specific gravity of hot salt on the hydraulic axial thrust of the pump. For an axial-flow propeller pump the axial thrust is approximately equal to the suction opening of the pump in square inches multiplied by the pump total head in pounds per square inch. Evidently the hydraulic axial thrust will be greater in the ratio of specific gravity when pumping hot salt. This is usually taken up by the motor thrust bearing which requires special design.

The matter is more complicated by the fact that the pumps have to work against shut-off head at times when the discharge valve is closed and the head under these conditions may be more than twice the normal operating head. The axial thrust is increased accordingly. For a pump with a capacity of 17,000 G.P.M. at normal head of 45 feet, the normal hydraulic axial thrust when pumping hot salt is about 16,000 pounds, and with the discharge valve shut off the thrust is about 32,000 pounds, excluding the weight of the rotating element.

The question was brought up on several occasions whether the hydraulic thrust carried by the motor thrust bearing imposes any load on the motor support in addition to pump dead weight. The answer is negative, because the pumping unit including motor (Figure 1) represent a closed system and hydraulic thrust is an internal force imposing strains on some elements of the system, but giving no component outside of the unit. It should be borne in mind that all forces appear in pairs—action and reaction. When hydraulic thrust is exerted on the impeller vanes and hub downward, an equal force is applied to the pump casing in the opposite direction. While the axial thrust is transmitted to the motor

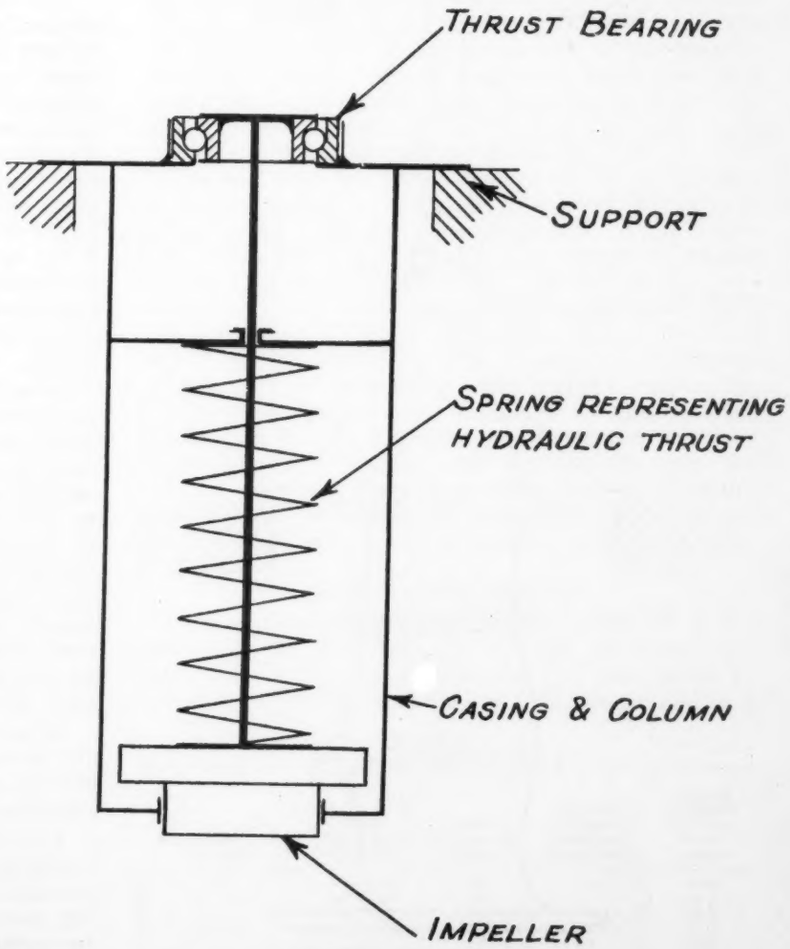

FIGURE 2
Support does not carry spring tension

thrust bearing and exerts a downward force on the motor frame, an equal force is transmitted from the pump casing through the column in the opposite direction or upward.

The whole system can be compared to a container or a box with a spring inside it (Figure 2). Evidently the spring tension does not contribute any load to the box support.

It should be noted that if the pumping element (pump bowl) has an independent support from the motor (Figure 3), then the motor support carries full hydraulic axial thrust. Such an arrangement is not used in the refinery application of the propeller pumps but is common with water pumps of large size when the motor floor is high above the pump sump.

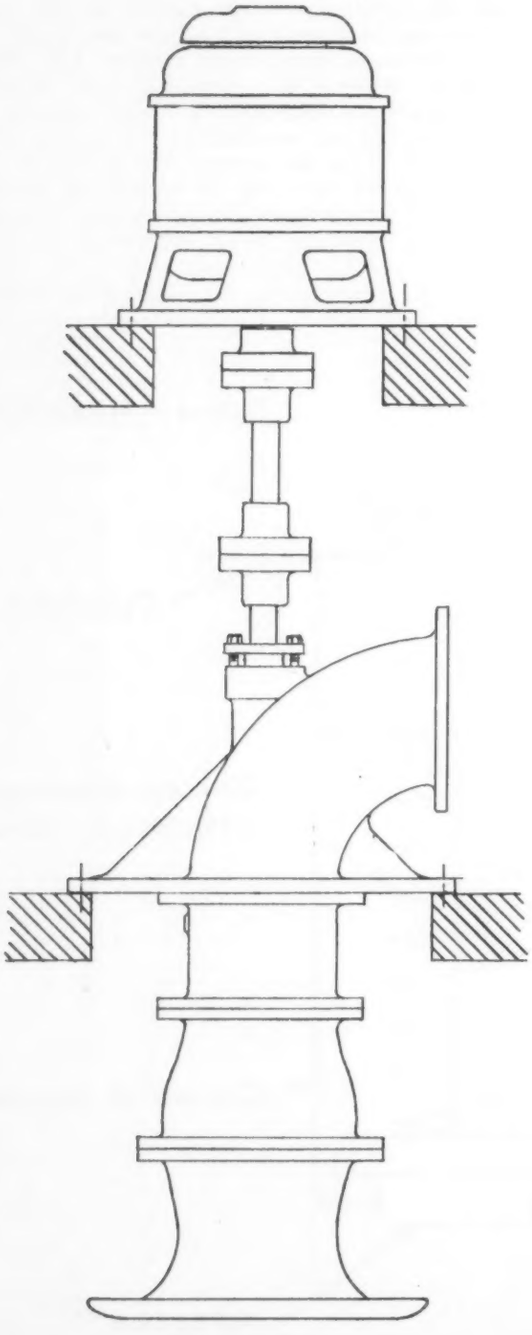

FIGURE 3
Hydraulic Thrust Carried by Motor Support

As a result of high hydraulic thrust when pumping hot salt of high specific gravity it is impossible to operate pumps on hot salt with the minimum clearances between the impeller and the casing, such as are possible when pumping water, as at shut-off the impeller will rub against its seat (except in true axial flow pumps) due to shaft extension.

Case Reaction Reduces Bolt Stresses

It is interesting to note that the case reaction due to the axial thrust reduces the bolt tension in the flanges of the pump bowl assembly and the discharge pipe. In the case of low-pressure pumps this is of no consequence. However, in the high-pressure multistage vertical pumps of the deep-well type, this is a very important feature. Although the inside pressure is increasing from stage to stage in deep-well pumps, the bolting holding stages together is essentially under the same stress for all stages. This is very fortunate as space limitation does not permit using heavy bolting in deep-well pumps. Doubling the number of bolts, practices often with large numbers of stages, is not always justified.

Control of Power and Capacity

The high brake horsepower at shut-off of propeller pumps has caused serious concern to the plant designers and operators. The catalytic cracking operations require regeneration of the hot salt. Hot salt containers are arranged so that operation is continuous, some operating while others are regenerating. The change from one to the other requires pump operation for short intervals with the discharge valve shut. High shut-off power requires driving motor larger than the normal load indicates. In some cases it has been found that more economical arrangement is obtained by using slow-speed larger pumps with flat power curve, rather than to buy an oversize motor for a higher-speed pump with high shut-off power.

In water pumps required to operate with discharge valve closed a simple method has been developed to avoid the high power demand at shut-off. This consists of a by-pass on the discharge column, which is opened when the main discharge is closed. If the by-pass nozzle is properly shaped and located as low as possible on the discharge column to reduce pipe friction loss and static head to the nozzle to a minimum, full pump capacity can be by-passed to suction supply through a nozzle about half size of the pump main discharge. The by-pass can be made automatic by using weighted flap or check valve, which opens only when head exceeds the normal head.

In water pumps a by-pass has been used to regulate the pump capacity. This is more economical than throttling the main discharge, as the power is decreasing when the capacity is increasing.

Possibly a similar control of power and capacity could be applied advantageously to the problem of circulation of hot salt in the catalytic refining process, but more information about the process itself should be available for the pump engineers to make an intelligent recommendation, which is not the case at the present time.

Phosphorus-Pentoxide As a Refining Agent

HEINZ HEINEMANN*

PHOSPHORUS-PENTOXIDE has long been known as a polymerizing catalyst and has often been described in the literature.[1, 2, 3] Due to its ability of slowly polymerizing and alkylating olefines,[4, 5, 6] it can be used under well defined favorable conditions as a comparatively selective polymerization catalyst for diolefines and acetylenes. This means that under such conditions, and due to the greater tendency of diolefines as compared with monoölefines to polymerize,[7] these compounds will be converted while monoölefines are not affected. Since diolefines constitute most of the gum-forming substances, selective treatment with P_2O_5 provides a method to remove potential gum from gasolines, polymerizing the diolefines to high-boiling substances which are separated from the gasoline by distillation, while not affecting the monoölefines in the gasoline and thus preventing losses which might be caused by the polymerization of olefines boiling in the gasoline range.

One difficulty encountered in contacting gasoline or gasoline vapors with P_2O_5 is that the phosphorus-pentoxide conglomerates and forms lumps which reduce the active surface considerably. Malishev[8] proposes the use of protecting colloids like carbon black and peptizing agents like cresol to overcome this. A. P. Sachs[9] pretreats the gasoline with a partially spent emulsion of phosphorus-pentoxide in oil, which will contain some phosphoric acid.

Refining Effect Only

While both Malishev and Sachs consider a simultaneous step of refining gasoline and alkylating its paraffines and (or) aromatics with olefines (partly in analogy to reactions with aluminum chloride[10]), this article is restricted to the refining effect of P_2O_5 only. Though the danger of coagulation of phosphorus-pentoxide can be avoided by either of the two methods described, it has also been found that, when phosphorus-pentoxide is suspended in a hot oil by injecting it in small quantities into the circulating liquid while the suspension is kept hot, it will not conglomerate, even if the fresh suspension is contacted with gasoline.

Malishev's method of contacting the gasoline with a solid mass of catalyst leads to a rather rapid exhaustion of the catalyst although no coagulation occurs. This is due to a deposit of polymers formed from diolefines on the catalyst surface. If the P_2O_5 is suspended in a hot oil which has a good solvency for polymers the catalyst's life can be prolonged as much as 35 times, the oil dissolving formed gum and preventing its deposit on the catalyst surface.

In applying this method, two things are essential. The suspension oil must have a boiling range above that of the gasoline and it must be kept at a temperature above the end point of the gasoline, allowing the gasoline vapors to bubble through the suspension without condensation (and subsequent dilution of the suspension) and without taking part of the suspension oil overhead. These conditions limit operation temperatures to a close range, allowing pressure and reaction time as the only variables of influence upon the operation. These will be discussed later on.

The fact that the concentration of the suspension is of great influence on the catalyst life (Figure 1) is taken as proof for the solvency theory. While a certain minimum concentration is necessary to enable complete contact, the time elapsing before the suspension is spent is the longer the greater the oil-P_2O_5 ratio. Adding of fresh phosphorus-pentoxide to a nearly spent suspension will prolong its efficiency only briefly, while adding fresh solvent (up to the minimum concentration) prolongs it considerably. Further, it has been found that since the solvency of most oils increases with the temperature, the catalyst life also increases with the temperature (Figure 2). Consequently the operation temperature should be as high as the previously mentioned limitations permit.

Gum Content Influence

Another factor of influence upon the lifetime of the catalyst is the potential gum content (as fairly well expressed by the copper-dish gum) of the charge to the treating unit. One pound of P_2O_5 suspended in a

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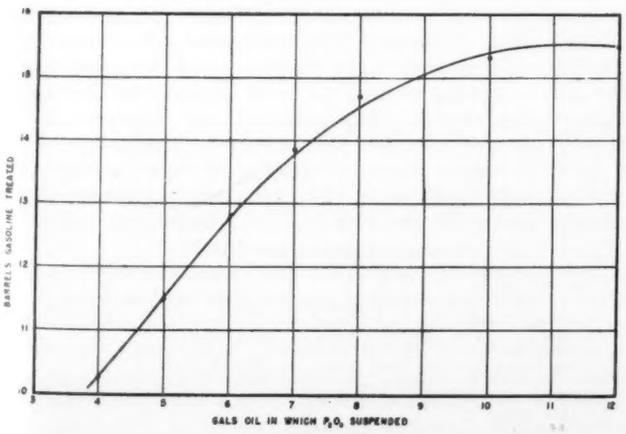

FIGURE 1

TABLE 1

Reaction Time Seconds	Lbs. Operating Pressure	Percent Olefines in Charge	Percent Olefines in Finished Gasoline	Percent Finished Gasoline From Charge
10	Atmosph.	38	39	99.6
15	Atmosph.	38	37	99.5
20	Atmosph.	41	33	98.0
25	Atmosph.	41	30	97.0
15	10	37	37	99.5
15	30	37	31	98.0
15	45	37	27	96.0
15	60	37	25	95.0

TABLE 2

	I		II	
	Charge Gasoline	Finished Gasoline	Charge Gasoline	Finished Gasoline
Gravity	58.2	59.1	56.1	57.0
I. B. P.	98	101	97	95
10 percent	141	139	149	144
50 percent	278	281	292	276
90 percent	361	351	379	366
F. E. P.	410	403	421	420
Color	3	30+	1	30+
A. S. T. M. gum	..	1	12	0.5
Cu-Dish gum	521	27	421	19
Sulphur	.162	.157	..	..
R. V. P.	9.0	8.3	8.1	7.8
Ind. Period	65	290	60	255
Octane No. (C.F.R.)	72	72	70.5	71.0

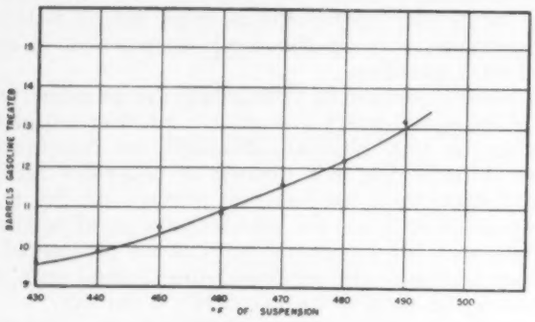

FIGURE 2

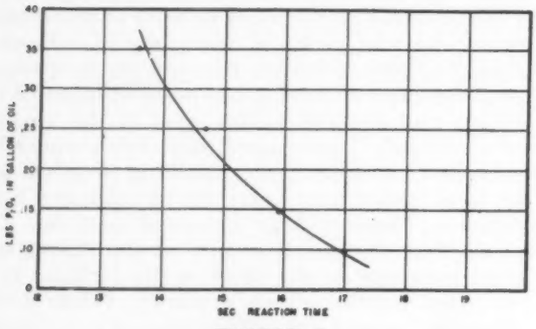

FIGURE 3

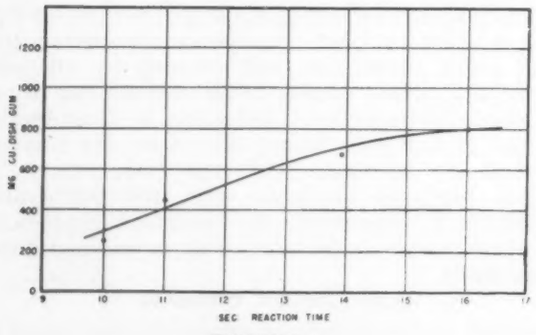

FIGURE 4

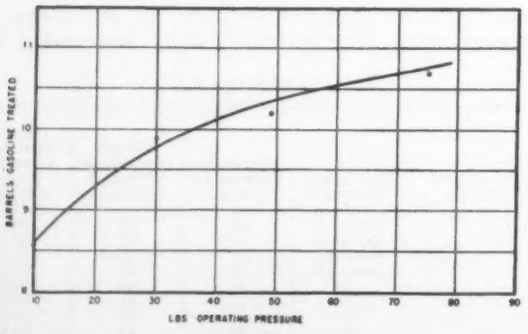

FIGURE 5

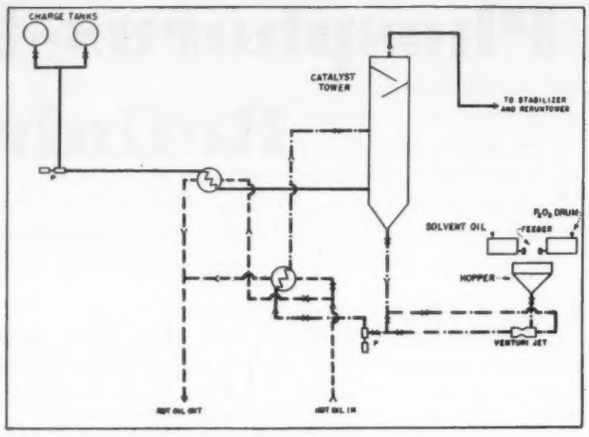

FIGURE 6

certain amount of oil will remove a definite amount of diolefines and acetylenes and consequently will treat less charge stock of a high than of a low Cu-dish gum content.

The influence of pressure and reaction time on the reaction are of importance. There is a definite relation between the P_2O_5 content of the suspension and the reaction time (Figure 3). The more concentrated the suspension is, the shorter is the reaction time required. Since, however, for previously mentioned reasons, the concentration of phosphorus-pentoxide should be kept near a minimum, a minimum reaction time is given which in turn is dependent on the Cu-dish gum of the charge stock. (Figure 4). The longer the reaction time, the more complete the removal of gum-forming substances. However, with increasing reaction time, an increasing polymerization of monoölefines and subsequent losses in yield were observed (Table 1) so that a commercially feasible compromise has to be made.

While the results discussed so far were obtained at operation under atmospheric pressure, an increase in pressure works practically in the same manner as a prolongation of reaction time, destroying the effect of selective polymerization otherwise obtained and increasingly polymerizing the monoölefines (Table 1). The catalyst life, however is prolonged by increasing pressure (Figure 5) and it has been found that a pressure of about 30 pounds is most recommendable.

It should also be mentioned that the process as described is non-corrosive.

The results described were obtained in a pilot plant (Figure 6) which was similar to that described by Sachs.[9] The refining effects obtained are shown in Table 2. No considerable loss in yield occurred and the octane rating was equal to or slightly better than that of the charge. The influence of sulphur compounds on the catalyst seemed to be negligible.

The procedure appears, in spite of higher chemical cost, competitive with clay treatment, due to the smaller losses in yield and no loss in octane rating.

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Factors in the Synthesis of Kogasin and Paraffin in Water-Phase

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Translated from Brennstoff-Chemie, vol. 20, 13, p. 247 (1939)

THE above title is intended more to convey our views derived from the following scientific observations of the principles underlying the original kogasin synthesis from carbon monoxide and hydrogen rather than to propose a fully developed technique for large-scale manufacturing operations. The observations we have made appear so valuable and interesting that it was deemed of scientific value to describe them at this time.

It is already known from the researches carried out in this institute that the kogasin and paraffin syntheses from carbon monoxide and hydrogen, using catalysts, can only be achieved with good yields, and long catalyst contact-time, when the required temperature is held within quite narrow limits. This requirement is generally difficult to attain, due to the strongly exothermic nature of the reaction: $CO + 2H_2 = CH_2 + H_2O$. The liberated heat of reaction must be carried away continuously without allowing any temperature drops. In the course of years we have attempted to accomplish this in our institute in various ways. The most important procedures are shown in tabulated Summary I.

SUMMARY I

Removal of Heat of Reaction and Holding Temperatures Constant.

1. Circulating oil outside of the catalyst chamber.
2. Catalyst suspended in paraffin oil (oil-phase).
3. Circulating superheated water outside the catalyst-chamber, viz. about 180° C. (about at 10 atm.)
4. Catalyst suspended in superheated water, (180° C. at 10 atm.) watery-phase.

1. Pipes of about 10 mm. width, containing the catalyst, were cooled by circulating around them a high-boiling oil. The use of selected cooling oils presented no difficulty even though a reaction temperature of around 200° C. had to be necessarily maintained.

2. Instead of withdrawing the reaction-heat through the tube-walls, it was withdrawn directly from the catalyst by agitation with the oil—that is, the catalyst was suspended in paraffin oil and kept suspended mechanically—working thus in the oil phase. Experiments in this direction were carried out with nickel, cobalt, and later on with iron and ruthenium catalysts. It was generally found that the synthesis could be substantially carried out in this manner, but that, considering practical adaptation, larger chambers were needed than when working in the gas-phase, that considerable mechanical energy is needed in order to keep the catalyst finely divided and turbulently suspended, and finally that when we employed nickel, this catalyst was lost in the form of carbonyl being carried out of the apparatus by the stream of gas.

Our original ideas that the kogasin synthesis was not possible in the oil phase because the absorption of the high-boiling oil used as a suspension medium for the catalyst might prevent the absorption of carbon monoxide and hydrogen, according to analogous theories, have been changed and revised by our recent experiments. These results are not exactly surprising since it is now known, when working at ordinary pressures in the gas phase, that the catalyst is always soaked with high-boiling reaction products, especially molten wax, without the reaction coming to a standstill.

3. Still better than removing the reaction heat by externally circulating oil, are the provisions for removing the same by externally circulating superheated water, for instance, at 200° C. Even though there is the complication that the cooling chambers must be pressure proof, in order to hold the water in the liquid state, the greater specific heat of water, and especially the fact that the heat of reaction can be carried away at a constant temperature and used as heat of vaporization—these factors give so many advantages that commercial technique has chosen this system.

4. Even though working in the oil phase has not recommended itself any too well for practical operations, due to reasons already stated, it did seem of important scientific interest to definitely determine whether the kogasin synthesis was possible at all in the water phase. Since nothing definite could be predicted we embarked on an extensive experimental program. For instance, the catalyst had to be kept suspended in superheated water at 200° C. instead of in oil, this calling for especially strongly-built pressure vessels. The monoxide-hydrogen mixture was led under pressure into this apparatus at a higher pressure than was the vapor pressure of water at 200° C., and sufficiently high to be maintained constant at all times. The exit gases had to be released through a pressure cooler so that any entrained water-vapor could flow back into the apparatus. It is doubtful that when working in the water phase the physical conditions were just ideal for maintaining a constant temperature and for removing the heat of reaction; it was not excluded, however, that the carbon monoxide, due to the high concentration of the water-vapor, was consumed partially or completely on account of an undesirable side reaction; as a result, carbon dioxide and hydrogen form according to the water-gas reaction. The experiment was, however, not altogether hopeless, since it is

known that for example, water vapor forms in the reaction where working the synthesis with cobalt catalysts at normal and slight pressures. The water vapor also is found in appreciable quantities above the catalyst before all the carbon monoxide is consumed, forming hydrocarbons. By ordinary procedures, too, the quantity of carbon dioxide which is formed is not large, so that one can conclude that very little carbon monoxide will be consumed in such side reactions.

It was also from a purely chemical point of view quite important to know how the synthesis completed itself in water phase, where instead of pure water one employed neutral acid or alkaline aqueous solutions—a question which can only be answered by operating in the water phase. It was also necessary to test the action and behavior of various catalysts, like nickel, cobalt, iron and ruthenium.

Since we had known that small amounts of organic acids will form[1] in the synthesis at normal and medium pressures, we therefore used a pressure vessel lined with copper when working in the water phase; in the water phase we found organic acids would concentrate in the water. Also the auxiliary parts of the apparatus such as the pressure coolings vessel was copper-clad.

The horizontal pressure vessel contains a stirrer made of copper—a blade almost as wide as the internal diameter of the vessel, and which blade is perforated with many small holes to aid in thorough mixing. The blade or stirrer fits almost snugly into the vessel. This blade stirred the catalyst into a strong turbulent motion, keeping the former well suspended and well mixed with the gas mix without offering too much friction for the gas passage. The speed of stirring controlled the conversion to a great degree. The faster stirring action always giving greater yields. A limit is reached when too great a speed throws catalyst in the suspension into the cooler. Usually 120 r.p.m. was found to be efficient. Attached to the vessel is a pressure cooler from which the exit gases could be released through a valve. The water and the non-volatiles flow back into the reaction vessel from this cooler. The upper end of the pressure cooler was connected to the inner chamber of the stuffing gland on the stirrer by a pipe connection. By this means an equal pressure was maintained on the stuffing gland side and on the lubricator side so that the liquid contents of the vessel remained intact without being driven out by unequal pressure; in this manner, too, the shaft could be lubricated at all times.

The pressure-reaction chamber made of unalloyed steel and cylindrical in shape is 27.5 cm. long, and is 7 cm. wide (int. diam.) with a capacity of about 1000 cc. Five hundred cc. of water were used to fill the vessel which allowed sufficient liquid water, even though some of it evaporated or was converted to steam at 200° C., to be present at all times. This water contained the suspended catalyst. The catalyst was used always after it was first freshly reduced and had been stored and charged under carbon dioxide gas pressure.

We always first tested out the catalyst as to its activity in a synthesis at ordinary pressure.

The reacting gas mix next was led in under pressure once the vessel was tightened up to the desired working pressure, after which the contents were heated to the desired temperature. The composition of the incoming gas was known, the exit gases were tested. The contraction was calculated from the change in the percent of nitrogen.

Some of our experiments are given below, when using Ni, Co, Fe, and Ru. Where various types of water phases were used, the results are shown as sub-titled with the specific catalyst.

SUMMARY II

Conditions and Results with Nickel

Catalyst	Ni, Thor. catalyst in water-phase.
Gas	$Co:H_2=1:2$
Temperature	170° C.
Water-vapor press.	7 atm.
Total press.	55 inches
Gas press.	48 inches
Time	24 hrs.
Contraction	40%
Product	Nickel carbonyl, as is known to form, and its loss from the zone of activity.

The above gives the conditions in which a nickel thorium catalyst was used at 170° C. The water-vapor pressure at 170° C. is 7 at. Since the total pressure in the apparatus was 55 atm., the partial pressure of the CO : H mix was 48 atm.

We only spent 24 hours with this reaction since the same thing happened here as in all cases where working with nickel at these temperatures and at high CO pressures—namely, the loss by evaporation as nickel carbonyl of nearly all the nickel that had been added. Here the active centers of the catalyst are rendered inert, and in the course of time all of the nickel leaves the apparatus with the exit gases in that form.

SUMMARY III

Results with Cobalt Catalyst

Catalyst	Co-Thor, in water-phase.
Gas	Mix of $Co:H_2=1:2$.
Suspension Medium	
1. Dist'd Water at 170 C.	
Water-vapor press.	7 atm.
Total press.	56 atm.
Gas press.	49 atm.
Time	10 days.
Contraction	40-70%.
Products: Hydrocarbons—of which is:	
benzine	20%
oil	20%
paraffin	60%
M.P. of the paraffin from 50 to over 100° C. Some of the cobalt is in solution in the water as a salt of some fatty acid. Reaction of the water is acidic.	
2. Sodium Formate Solution.	
Theory: NaON or sod. carbonate with CO gives sodium formate.	
Results—not good. $CO + H_2O = CO_2 + H_2$	
3. Potassium fluoride Solution.	
Very poor results.	

In Summary III are data using cobalt-thorium. Since this catalyst did not volatilize under the conditions, the duration of our experiment was extended to 10 days and quite a quantity of product was collected. The experiment shows that this catalyst functions similarly as in the absence of fluid water, as also in the case of the medium pressure synthesis of Fischer and Pichler.

There were free fatty acids present in the 500 cc. of water and as evidenced by the rose-colored solution, we found some cobalt in the solution combined with fatty acids.

In order to prevent attack of the cobalt by acids

[1] H. Koch, H. Pichler, & H. Kolbel, Brennst-Chem. 16/382 (1935).

concentrating in the water, one thought of using a solution of sodium carbonate instead of the 500 cc. of water. But it is well known of course that if this is done carbon monoxide will go in solution as sodium formate, under these conditions. With this in mind, we conducted the next experiment using sodium formate solution already formed at the start. The result was definitely poorer than with straight water. Carbon monoxide with water is easily converted to the dioxide and free hydrogen.

For other reasons we also experimented with a sodium fluoride solution, obtaining even worse results.

SUMMARY IV
Results Using Iron Catalyst

Catalyst .....iron in water phase.
Gas .....$CO : H_2 = 2:1$.
Suspension medium: Dist'd water; in other experiments using 3N phosphoric acid.
Temperature .....200-250° C.
Water-vapor press..15-40 atm.
Total press.....50-80 atm.
Gas press.....35-40 atm.
Time .....8 days.
Contraction .....None; expansion.
Product .....None but the products: hydrogen and carbon dioxide.
Reasons: Temp. and Fe as a catalyst.

In experiment No. 4 an iron catalyst prepared by precipitation was used. Gas mix is given above. Since iron catalysts require higher temperatures, the reaction temperature was held at 200-250° C. Time 8 days. There was no contraction—only an expansion due to the water-gas reaction yielding carbon dioxide and hydrogen.

We give below data from 6 experiments using again a normal mix of gas and ruthenium as catalyst. The data are classed according to the method of suspending the catalyst.

SUMMARY V
Results Using Ruthenium

Catalyst .....Ruthenium in water-phase.
Gas .....A mix of $CO : H_2 = 1:2$.
Suspending medium:
1. H_2O; 2. K_2RuO_4 solution; 3. 3N H_3PO_4; 4. 3N HCOOH; 5. CH_3COOH; 6. $H_2C_2O_4$.

Trial No. 1—HO:

Temp.....175° C.
Water-vapor press..8 atm.
Total press.....105 atm.
Gas press. .....97 atm.
Time .....10 days.
Contraction .....Easily reproducible 50-60%.
Products .....Fluid (10-20%) & solid (80-90%) of hydrocarbons.
One half of the paraffin melts between 50-127° C.; the other half at over 127° C.

Trial No. 2—Potassium Ruthenate Solution.

Results: The solution in the apparatus was converted to pot. formate and carbonate, and contained precipitated ruthenium.

The catalyst combination was unsatisfactory. Since we had known that ruthenium functions well at high gas pressures, we accordingly always operated at 90-100 atm. The first trial with distilled water as the suspension medium, using freshly prepared finely divided ruthenium metal as a catalyst, lasted 10 days. The contraction was well constant at 50-60 percent. The product contained 80-90 percent solid paraffin—namely, synthetic ceresin; liquid products were 10-20 percent—one half of the solids melted over 127° C.

As seen under "Trial 2" above, we next used a solution of potassium ruthenate as catalyst—without first precipitating the ruthenium. The results of the experiment were about the same as in No. 1 trial only not as good. Potassium formate formed due to the carbon monoxide, and ruthenium precipitated out—although not in such a finely divided form as we had first employed it in Trial No. 1.

SUMMARY VI
Results Using Ruthenium

Trial No. 3—3 Normal Phosphoric acid.
Gas .....$CO : H_2 = 1:2$.
Temp. .....170-180° C.
Water-vapor press..7-9 atm.
Total press.....About 100 atm.
Gas press.....About 90 atm.
Time .....9 days.
Contraction .....60-66%.
Yield .....135 gm per N cu. meter.
Products .....35% solids, soluble in boiling ether: m.p. 77° C.
27% solids soluble in hot benzole: m.p. 103° C.
35% solids soluble in hot toluol: m.p. to 130° C.
1-2% fatty acids.

Copper lining easily attacked by the phosphoric acid. The catalyst as a metal or as carbide is stable against 3N phosphoric acid.

In Experiment VI we worked with an acid solution in order to determine if the usual reaction would also occur in such a medium. The conditions were the same therefore as in Experiment V. Time 9 days, contraction was 60-66 percent. Even though using phosphoric acid, we observed no other reactions. For every normal cubic meter we obtained 135 gm. of solid hydrocarbons, which were extracted successively with boiling, ether, benzole, and toluol.

Three fractions were thus obtained melting at 77°, 103° and 130° C. In employing phosphoric acid we had hoped it would not attack the copper lining. The lining had been slightly attacked. Ruthenium carbide, the intermediate was stable towards the acid, however; otherwise, the desired synthesis would not have taken place.

Since we observed in Experiment V that the use of distilled water gave rise to water-soluble fatty acids, yet noticed no attack of the copper lining, we then performed one more experiment in which we used various organic acids, namely, formic, acetic, and oxalic—all in 3N solution.

Summary VII gives the results of the three trials. The copper lining remained unattacked with all three acids in 3N solution. The synthesis ran very smoothly especially with 3N acetic acid. Contraction was 50-70 percent, and we obtained for every normal cubic meter of gas about 120 gm. of solid paraffin mass. Otherwise the reaction proceeded about the same as when using distilled water or the 3N phosphoric acid as suspension medium.

SUMMARY VII
Results Using Ruthenium as Catalyst

Trials 4, 5, and 6: Formic, acetic, and oxalic acids.
No metal corrosion.
Best results with acetic acid.
Suspension medium.3N, CH_3 - COOH.
Temp. .....170-200° C.
Contraction .....50-70%.
Products .....120 gm. solid paraffins per N cu. m. Formic and oxalic acids less satisfactory.
Conclusion .....Organic acids do not disturb the synthesis.

How to Obtain and Maintain Hot Water

FOR the benefit of those who would like to know how to obtain hot water and how to keep it hot here are five self-explanatory sketches which completely show and describe the piping hook-up.

Figure 1 shows how to pipe a hot-water-storage tank. It is easily done by means of a hot-water-temperature regulator and a steam-control valve. The regulator is hydraulically operated. Simply connect to the service water system at the point marked "⅜-inch water pressure supply to regulator."

It operates in this way: When the temperature of the water reaches the desired point, the metallic expansion tube, which is inserted into the tank, expands and permits the water pressure to pass through the regulator to the diaphragm valve and shuts off the steam. When the temperature decreases the tube will contract, thereby discharging the pressure from the diaphragm valve and turning on the steam.

This type of temperature control is highly accurate and sensitive. It will easily operate within two degrees variation and can be adjusted to maintain the temperature where it belongs.

Tanks equipped with a control system of this kind operate at full capacity because the control valve stays wide open until the desired temperature is reached and then it closes completely. This is a desirable feature where valves are expensive or where continual valve tightness is wanted. In other words, there is no "wire drawing."

A regulator of this type will operate the largest steam or other control valve, at any pressure, with as little as 2 degrees variation in temperature. It is easily adjusted to act at any temperature up to 300° F.

Figure 2 shows how to pipe a hot-water heater and storage tank. The operation of the regulator is precisely the same as in Figure 1.

Figure 3 shows how to pipe an open tank. It will be observed that the piping arrangement for Figures 1, 2, and 3, is very much the same.

Next we run into a slightly more complex problem, Figure 4, which shows how to pipe two hot water generators, both control valves being operated by one hot-water regulator. An extension of this method will take care of any number of control valves.

Finally we have Figure 5 which shows how to pipe a hot-water generator using high-pressure supplementary steam for doing the heating. It is assumed here that the low-pressure steam supply need not be regulated at all because it is insufficient in quantity. Some high-pressure steam must therefore be automatically added from time to time.

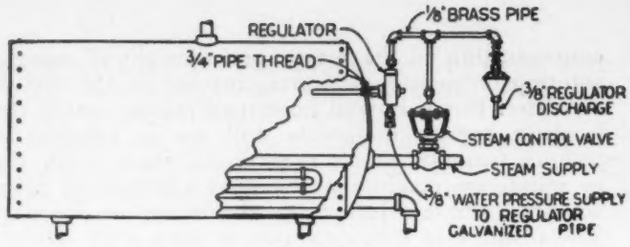


FIGURE 1

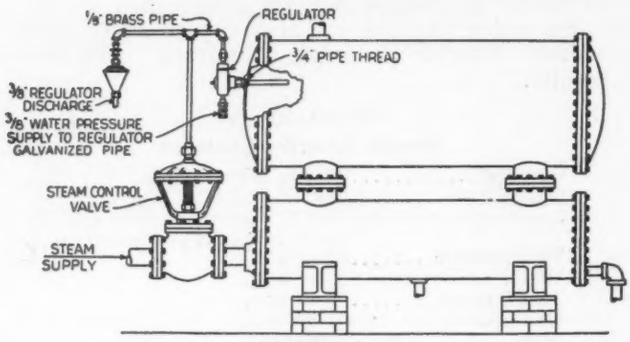


FIGURE 2

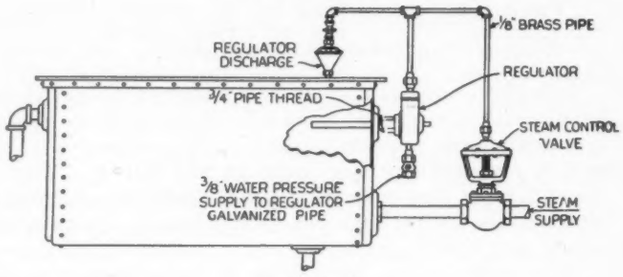


FIGURE 3

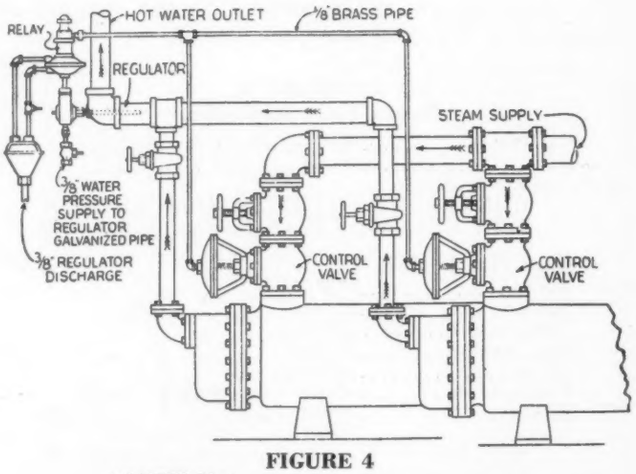


FIGURE 4

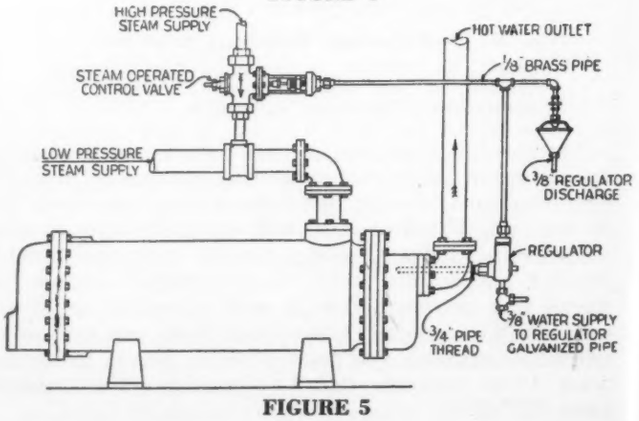


FIGURE 5

PENBERTHY PRODUCTS

Reflex

DROP FORGED STEEL LIQUID LEVEL GAGE

EMPTY SPACE SHOWS **WHITE** | LIQUID SHOWS **BLACK**

* * *

Transparent

DROP FORGED STEEL LIQUID LEVEL GAGE

USED TO OBSERVE COLOR AND DENSITY OF LIQUIDS UNDER HIGH PRESSURES, AND/OR TEMPERATURES

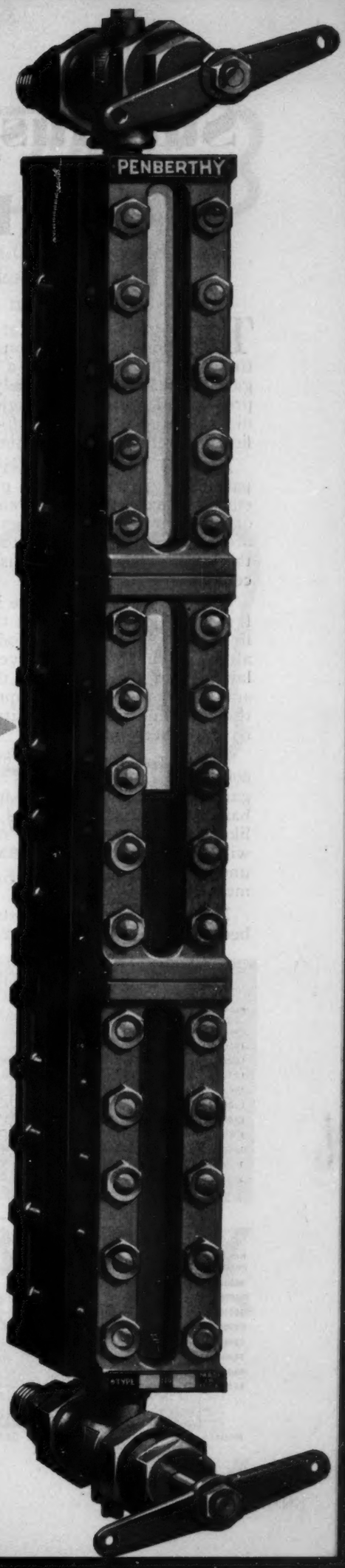
These gages are made of alloy temperature resisting steel and are of the highest quality throughout. Liquid chamber (both single and multiple section) is made from a solid block of steel to assure perfect alignment and rigidity. Frame has extra heavy beam at each end and glass chamber is accurately machined to contour of glass providing full metal backing for gaskets. Gage valves are drop forged steel with stainless trim.

These gages are available in any length and for various pressures and temperatures. All Penberthy gages conform with A. P. I.—A. S. M. E. requirements.

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN

Canadian Plant: WINDSOR, ONTARIO



Surplus Gasoline Chief Defect In Oil Situation

JACK LOGAN

THE industry's situation continues to be featured by a weak gasoline market, which likely will prevail indefinitely, although that disadvantage is partially offset by firm markets for other products.

Demand for petroleum is comparatively good, despite greatly curtailed exports, and inventories of most products except gasoline are satisfactory, although stocks of the latter product are seriously excessive.

Current operations of the industry, in the oil fields and at the refineries, are reasonably moderate, although runs to stills have been larger than desirable, with the result that prospects for improving the gasoline inventory situation have not been bright.

Totaling approximately 80,000,000 barrels, gasoline stocks are regarded as excessive by 15,000,000 barrels, and it is believed more likely than not that this surplus will be carried through the winter undiminished, or possibly augmented.

In recent years, the industry has been accumulating around 25,000,000 barrels of gasoline in storage during the fall-winter period, and if a similar build-up occurs this season, the oil companies will go into the spring-summer period of large consumption with 105,000,000 barrels of gasoline on hand.

That quantity would be 20,000,000 barrels in excess of needed working stocks even at the beginning of spring, as past experience has indicated that 85,000,000 barrels of gasoline in storage March 31, 1941, would be adequate for assuring prompt and efficient satisfaction of any requirements of consumers.

Last spring the gasoline stocks reached an all-time peak of 103,710,000 barrels, on March 31, and there was practically no withdrawal from storage until after April 30.

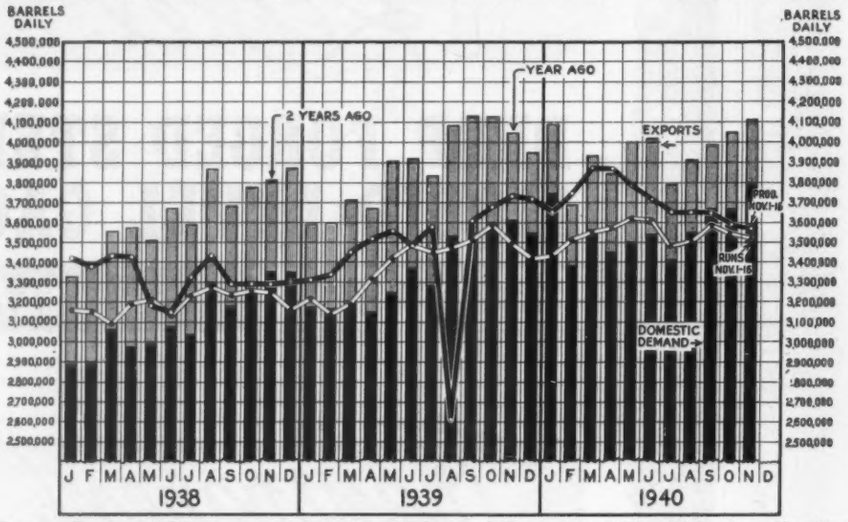
It is quite possible, however, that the gasoline stocks at the end of the coming winter may equal or exceed that peak.

Consequently, the outlook for the market for gasoline, principal product of the industry, is not at all promising.

During the past year prices of gasoline have been greatly depressed, because of the surplus quantities in the storage tanks, and an extension of the price situation through another year is threatened.

An accompanying table shows the extremely low levels to which service station prices of gasoline have declined, the figures being average prices per gallon in 50 rep-

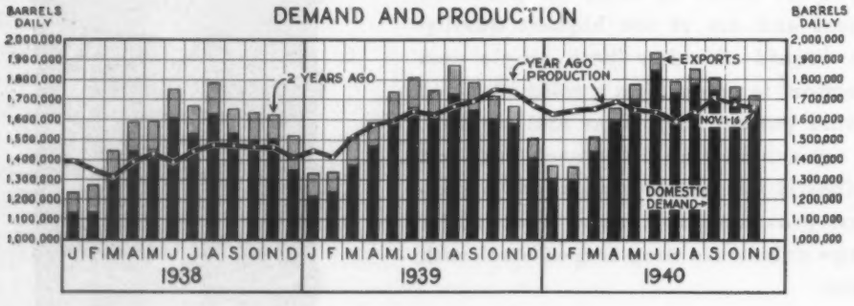
DEMAND FOR ALL U.S. OILS - CRUDE OIL PRODUCTION - REFINERY RUNS



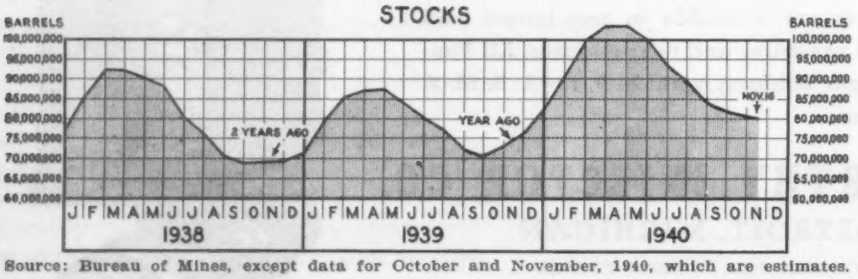
Source: Bureau of Mines, except data for October and November, 1940, which are estimates.

GASOLINE SITUATION

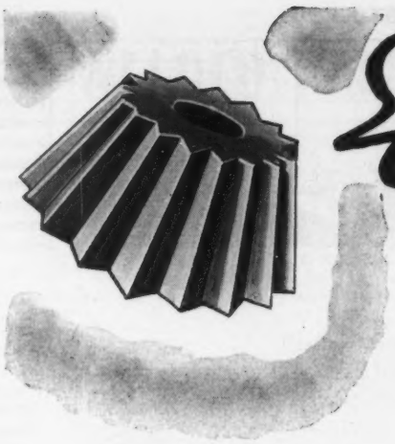
DEMAND AND PRODUCTION


BARRELS DAILY
2 YEARS AGO
YEAR AGO PRODUCTION
EXPORTS
DOMESTIC DEMAND
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1938
1939
1940

STOCKS



Source: Bureau of Mines, except data for October and November, 1940, which are estimates.



"I'M A HARD GUY!"

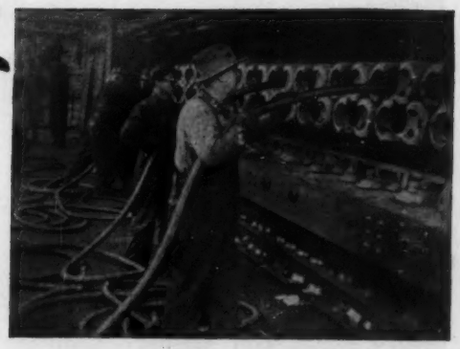
The toughening process I've been through would make a defeated heavy-weight seem like a pampered kitten, but it's given me what I need in my business — hard tough edges that can gouge and tear and bite through the meanest coke that ever fouled a tube. My job is on the business end of a Lagonda-Liberty tube cleaner, along with a bunch of others like me, in a head that backs us up, and a motor that drives us through the opposition like shock troops through a Sunday School picnic.

"THIS IS ME WITH THE GANG"

We all work together, the smoothest, fastest team you ever saw. Nothing wonderful about that, because we're designed and made by an organization that's been developing, testing and improving tools like us since before the oil industry started.

"WE'RE IN THERE, WORKING"

— and are those tubes going to be clean when we get through! Clean and unscarred, because while we're tough on coke, we're tender to tube surfaces. Most refinery people are pretty interested in the way we work. **There's a booklet about us, and you can get it by asking for "Tube Cleaners for Oil Refineries." You'll find it good reading.**



LAGONDA - LIBERTY

TUBE CLEANERS FOR OIL REFINERIES

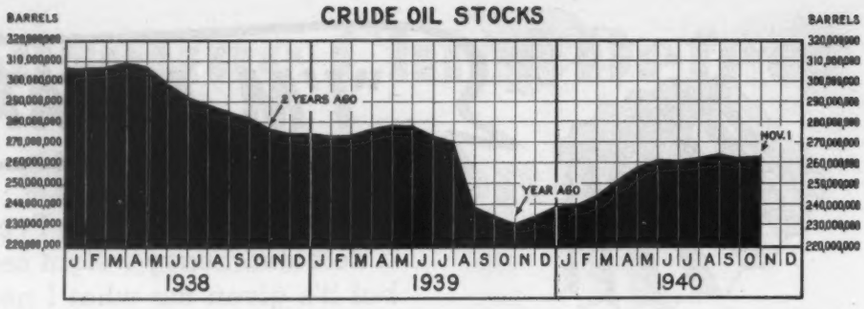
ELLIOTT COMPANY

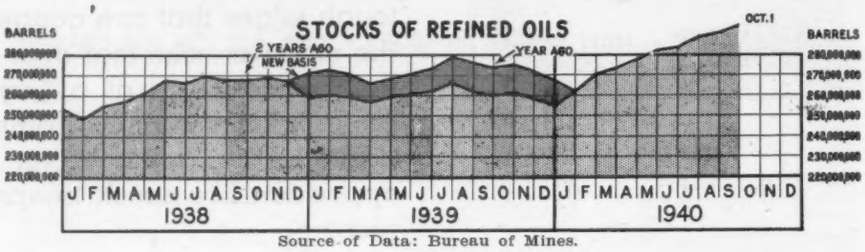
LAGONDA-LIBERTY Tube Cleaner Dept., SPRINGFIELD, OHIO

Y-156

resentative cities, as reported by the American Petroleum Institute.

Period	Cents Per Gal.
By Years:	
1937	14.59
1938	14.07
1939	13.31
1940 (10 Months)	12.87
By Months:	
1939—	
January	13.32
February	13.11
March	13.04
April	13.07
May	13.16
June	13.22
July	13.40
August	13.28
September	13.38
October	13.52
November	13.65
December	13.51
1940—	
January	13.53
February	13.43
March	13.34
April	13.17
May	12.91
June	12.66
July	12.53
August	12.58
September	12.33
October	12.20




STOCKS OF REFINED OILS
BARRELS
2 YEARS AGO
NEW BASIS
YEAR AGO
OCT. 1
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1938
1939
1940

Source of Data: Bureau of Mines.

Before commencement of the present fall-winter period, economists calculated that attainment of the ideal inventory of 85,000,000 barrels of gasoline as of March 31, 1941, would require the holding of refinery runs to an average of 3,400,000 barrels daily for the 6 months, under the assumption that yields of gasoline from crude would average only 43 percent.

However, in October and the first 16 days of November, runs to stills, as reported to the American Petroleum Institute, actually averaged 3,540,000 barrels daily, although they were below that average in several recent weeks.

Production of crude oil has been closer to economic levels than have the refinery operations. For maintaining runs to stills at 3,400,000 barrels daily, the necessary average for achieving an 85,000,000-barrel gasoline inventory at the end of the winter, crude production of 3,525,000 barrels would have been needed, on the average, making allowance for use in the oil fields and in other ways.

Actually, crude output in October and the first 16 days of November averaged 3,586,000 barrels, according to the weekly reports of the American Petroleum Institute.

Total Oil Demand Up 2 Percent for First 9 Months of 1940

Figures indicate barrels, and are from Bureau of Mines.

	SEPTEMBER			FIRST NINE MONTHS		
	1939	1940	Percent Change	1939	1940	Percent Change
SUMMARY						
Total Demand	124,723,000	119,639,000	— 4.1	1,044,589,000	1,071,329,000	+ 2.6
Daily Average	4,157,000	3,988,000	— 4.1	3,826,000	3,910,000	+ 2.2
Exports:						
Crude Petroleum	6,925,000	4,260,000	— 38.5	55,147,000	40,452,000	— 26.6
Refined Products	10,797,000	‡5,288,000	— 51.0	90,731,000	61,983,000	— 31.7
Total Exports	17,722,000	9,544,000	— 46.1	145,878,000	102,435,000	— 29.9
Domestic Demand:						
Total domestic demand	107,001,000	110,091,000	+ 2.9	898,711,000	968,894,000	+ 7.8
Daily average	3,567,000	3,670,000	+ 2.9	3,292,000	3,536,000	+ 7.4
TOTAL DEMAND FOR PRODUCTS						
Motor Fuel:						
Domestic	49,347,000	52,297,000	+ 5.97	411,901,000	440,130,000	+ 6.8
*Exports	4,232,000	1,907,000	— 54.9	35,420,000	18,770,000	— 47.0
Total	53,579,000	54,204,000	+ 1.2	447,321,000	458,900,000	+ 2.6
Aviation Gasoline:						
(Included above):						
Domestic	†	463,000	.....	†	3,764,000	.....
Exports	207,000	301,000	+ 45.4	3,300,000	2,972,000	— 9.9
Total	.....	764,000	.....	.....	6,736,000	.....
Kerosene:						
Domestic	4,638,000	5,173,000	+ 11.5	42,846,000	48,592,000	+ 13.4
Exports	577,000	178,000	— 69.2	5,917,000	2,926,000	— 50.5
Total	5,215,000	5,351,000	+ 2.6	48,763,000	51,518,000	+ 5.6
Gas Oils and Distillate Fuels:						
Domestic	10,010,000	10,715,000	+ 7.0	96,324,000	113,747,000	+ 18.1
Exports	3,015,000	947,000	— 68.6	25,151,000	15,579,000	— 38.1
Total	13,025,000	11,662,000	— 10.5	121,475,000	129,326,000	+ 6.5
Residual Fuel Oils:						
Domestic	26,966,000	25,567,000	— 5.2	231,725,000	242,321,000	+ 4.6
Exports	1,624,000	1,552,000	— 4.4	13,758,000	12,464,000	— 9.4
Total	28,590,000	27,119,000	— 5.2	245,483,000	254,785,000	+ 3.8
Lubricants:						
Domestic	2,207,000	2,150,000	— 2.6	17,205,000	17,851,000	+ 3.8
Exports	1,012,000	393,000	— 61.2	8,496,000	8,620,000	+ 1.5
Total	3,219,000	2,543,000	— 21.0	25,701,000	26,471,000	+ 3.0
Wax (pounds):						
Domestic	32,651,000	37,988,000	+ 16.4	201,073,000	257,103,000	+ 27.9
Exports	30,193,000	11,428,000	— 6.2	186,479,000	159,194,000	— 14.6
Total	62,844,000	49,416,000	— 21.3	387,552,000	416,297,000	+ 7.4
Coke (short tons):						
Domestic	86,600	122,300	+ 4.1	1,014,300	1,029,400	+ 1.5
Exports	38,200	26,900	— 29.6	212,000	200,200	— 5.6
Total	124,800	149,200	+ 19.5	1,226,300	1,229,600	+ 0.3
Asphalt (short tons):						
Domestic	605,200	695,800	+ 14.9	3,719,300	3,911,700	+ 5.2
Exports	4,400	16,900	+329.5	34,500	231,600	+571.3
Total	609,600	712,700	+ 16.9	3,753,800	4,143,300	+ 10.4
Road Oil:						
Domestic	1,072,000	1,128,000	+ 5.2	6,986,000	6,697,000	— 4.1
Miscellaneous:						
Domestic	171,000	222,000	+ 29.8	1,677,000	1,579,000	— 5.9
Exports	14,000	42,000	+200.0	74,000	781,000	+955.4
Total	185,000	264,000	+ 42.7	1,751,000	2,360,000	+ 34.8

* Includes benzol, 1,000 barrels in September, 1940. † Not available. ‡ Exclusive of 10,000 barrels exported from non-contiguous territories but inclusive of 74,000 barrels shipped from U. S. to territories.

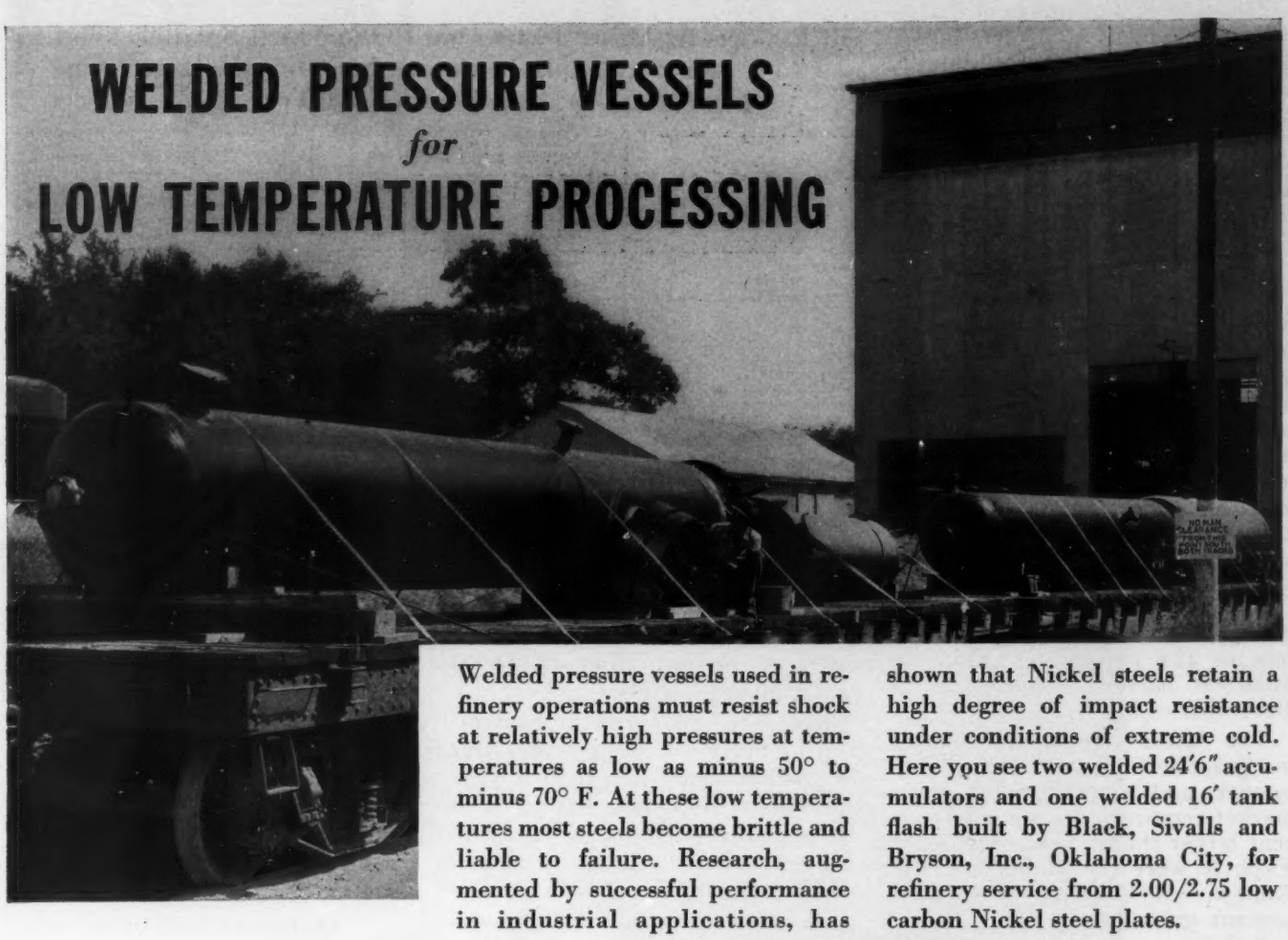
Demand for Petroleum

Total demand for petroleum in recent months has been somewhat smaller than a year ago, as small increases in domestic consumption have not compensated for the loss of export business.

In September, total demand was 4.1 percent smaller than in September, 1939, as domestic requirements showed a 2.9 percent increase, while exports of crude were down 38 percent and those of refined products in the aggregate were off 51 percent.

For the first 9 months of 1940,

WELDED PRESSURE VESSELS
for
LOW TEMPERATURE PROCESSING

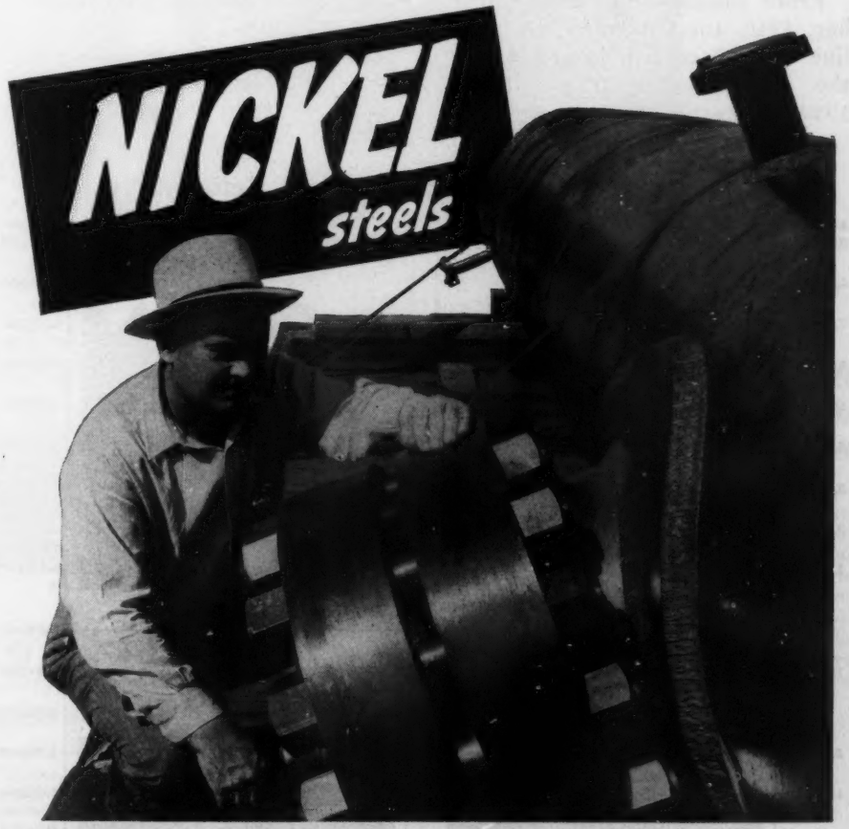


Welded pressure vessels used in refinery operations must resist shock at relatively high pressures at temperatures as low as minus 50° to minus 70° F. At these low temperatures most steels become brittle and liable to failure. Research, augmented by successful performance in industrial applications, has shown that Nickel steels retain a high degree of impact resistance under conditions of extreme cold. Here you see two welded 24′6″ accumulators and one welded 16′ tank flash built by Black, Sivalls and Bryson, Inc., Oklahoma City, for refinery service from 2.00/2.75 low carbon Nickel steel plates.

Close-up of a 42″ O. D. accumulator built by Black, Sivalls & Bryson, Inc., from Nickel alloy steel. Note the smooth weld made with Murex 2.25% Nickel steel electrodes, furnished by the Metal & Thermit Co. These jobs conform to ASTM specifications #A-203-37T, Grade B. Nickel steels are uniformly workable, weldable and dependable.

• • •

During the past 30 years, Nickel alloyed steels, cast irons and non-ferrous materials have been specified more and more for refinery applications subject to high heat, stress, corrosion and sub-zero temperatures. Your consultation is invited regarding money-saving applications of materials alloyed with Nickel.



THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

total demand was 2.2 percent larger than in the corresponding months of 1939, on a daily average basis. Domestic demand was up 7.4 percent. But exports were down 30 percent, as shipments of crude were off 27 percent, while those of refined products were down 32 percent.

Gasoline Situation

Continuation of the established trend of gasoline demand is anticipated. The Bureau of Mines in its monthly forecast for December estimated that total demand for motor fuel would be 2.7 percent larger than in December of last year. Domestic requirements were expected to be up 5.9 percent, to 46,400,000 barrels for December, 1940, from 43,807,000 barrels for December, 1939. Exports were expected to total about 1,800,000 barrels, or 42.6 percent less than the 3,136,000 barrels shipped out in December of last year.

The latest official information on gasoline demand covers September, and in that month, total market requirements were 1.2 percent larger than a year previously. Exports were off 55 percent, but domestic consumption showed a 6 percent gain.

From January through September, 1940, total demand for gasoline was 2.6 percent larger than in the corresponding 9 months of 1939. Domestic requirements were up 6.8 percent, but exports were down 47 percent, from 35,420,000 to 18,770,000 barrels.

Kerosene continued in September to move to foreign countries in smaller quantities than a year previously, shipments having been about 70 percent lower than in September of last year. But domestic demand was up 11.5 percent, and in consequence, there was a 2.6 percent gain in total requirements.

Total demand for kerosene was 5.6 percent larger in the first 9 months of 1940 than in the like months of 1939, despite a 50 percent drop in exports, from 5,917,000 to 2,926,000 barrels. For domestic consumption was up 13.4

[*Continued on page 92*]

Oil Exports in All of 1940 About One Third Smaller Than in 1939, and Shipments in September Only Half as Large as in That Month Last Year

ITEM	FIRST NINE MONTHS 1939	FIRST NINE MONTHS 1940	FIRST NINE MONTHS Percent Change	MONTH OF SEPTEMBER 1939	MONTH OF SEPTEMBER 1940	MONTH OF SEPTEMBER Percent Change
Crude Oil	55,147,000	40,452,000	— 27.0	6,925,000	4,260,000	— 38.5
Products:						
Motor Fuel	35,420,000	18,770,000	— 47.0	4,232,000	‡1,907,000	— 54.9
Aviation Gasoline (included above)	3,300,000	2,972,000	— 10.0	207,000	301,000	+ 45.4
Kerosene	5,917,000	2,926,000	— 51.0	577,000	178,000	— 69.2
Gas Oil and Distillate	25,151,000	15,579,000	— 38.1	3,015,000	947,000	— 68.2
Residual Fuel Oil	13,758,000	12,464,000	— 9.4	1,624,000	1,552,000	— 4.4
Lubricants	8,496,000	8,620,000	+ 15.0	1,012,000	393,000	— 61.2
Wax (pounds)	186,479,000	159,194,000	— 15.0	30,193,000	11,428,000	— 62.2
Coke (short tons)	212,000	200,000	— 6.0	38,200	26,900	— 29.6
Asphalt (short tons)	34,500	231,600	+571.3	4,400	16,900	+284.1
Miscellaneous Oils	74,000	781,000	+955.4	14,000	42,000	+200.0
*Total Refined Products	90,731,000	61,983,000	— 32.0	10,797,000	†5,288,000	— 51.0
Total Crude and Products	145,878,000	102,435,000	— 30.0	17,722,000	†9,548,000	— 46.1

* Not sum of the above figures, some of which do not indicate barrels. † Exclusive of 10,000 barrels exported from non-contiguous territories but inclusive of 74,000 barrels shipped from U. S. territories.
‡ Includes benzol, 1,000 barrels in September, 1940.

Changes From Year Ago in Stocks of Crude and Refined Oils in the United States

(Figures indicate barrels)

LATEST WEEKLY DATA

(Sources: Crude stocks, Bureau of Mines; all other figures American Petroleum Institute)

STOCKS OF:	November 16, 1939	November 16, 1940	Percent Change
Gasoline	75,170,000	80,063,000	+ 6.5
Gas Oil & Distillate	38,917,000	48,108,000	+26.6
Residual Fuel Oil	112,054,000	107,151,000	— 4.4
Crude Oil	*230,037,000	†261,631,000	+13.7

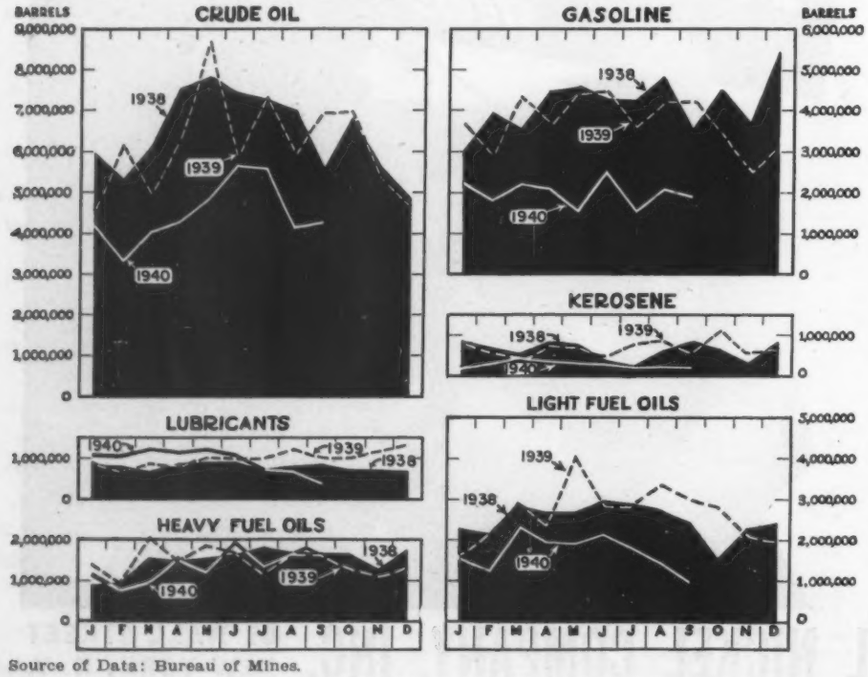
LATEST MONTHLY DATA

(Source: Bureau of Mines.)

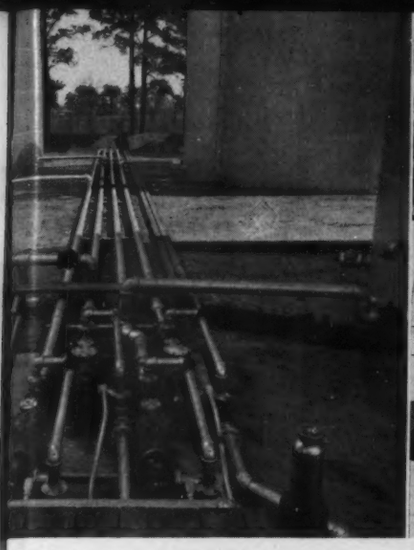
ITEM	Stocks at End of September 1939	1940	Percent Change
SUMMARY—			
Crude Petroleum:			
Refinable in U. S.	234,555,000	263,124,000	+12.2
Heavy in California	14,085,000	12,562,000	—16.2
Natural Gasoline	5,891,000	7,038,000	+19.5
Refined Products	274,028,000	294,095,000	+ 7.3
Total, all oils	528,559,000	576,819,000	+ 9.1
Day's supply:			
September basis	127	145	+14.2
9 Months Basis	138	148	+17.2
PRODUCTS—			
Gasoline:			
Finished	65,498,000	75,915,000	+15.9
Unfinished	5,494,000	5,992,000	+ 9.1
Total	70,992,000	81,907,000	+15.4
Aviation Gasoline (included above)	‡	5,428,000	.....
Kerosene	9,952,000	10,254,000	+ 3.0
Gas Oil & Distillate Fuels	38,138,000	48,828,000	+28.0
Residual Fuel Oils	100,063,000	94,947,000	— 5.1
Lubricants	6,704,000	8,596,000	+28.2
Wax (pounds)	89,584	110,028	+22.8
Coke (short tons)	668,000	617,000	— 7.6
Asphalt (short tons)	475,000	490,000	+ 3.2
Road Oil	791,000	844,000	+ 6.7
Miscellaneous	315,000	358,000	+13.7
Other Unfinished Oils	40,801,000	42,188,000	+ 3.4

* November 11, 1939
† November 9, 1940
‡ Not available.

U. S. Exports of Crude Petroleum and Refined Products



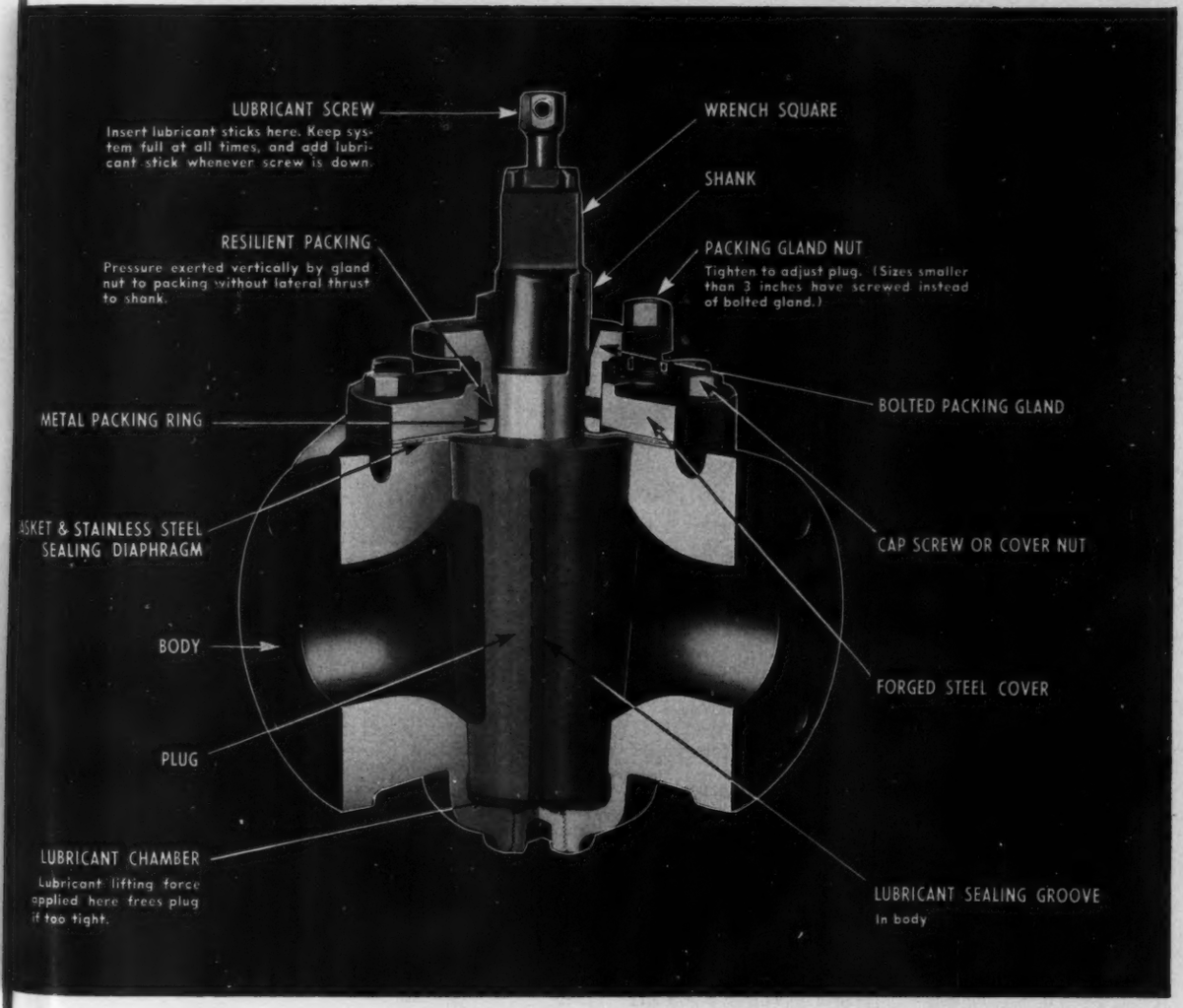
Source of Data: Bureau of Mines.



rdstrom Valves on manifold connect-g various storage tanks in a Florida bulk plant.

Nordstrom Valves on coolers in a Texas recycling plant.

Nordstrom Valves on a central manifold in a refinery where oil is treated and delivered to stock tanks.


LUBRICANT SCREW
Insert lubricant sticks here. Keep system full at all times, and add lubricant stick whenever screw is down.
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CAP SCREW OR COVER NUT
BODY
FORGED STEEL COVER
PLUG
LUBRICANT CHAMBER
Lubricant lifting force applied here frees plug if too tight.
LUBRICANT SEALING GROOVE
In body

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Surplus Gasoline Chief Defect in Oil Situation

[*Continued from page 88*]

percent, or almost 6,000,000 barrels, and that gain more than compensated for the decrease in exports.

Market requirements for light fuel oils failed in September to show an increase over September, 1939. Domestic demand was up 7 percent, but exports were off more than 2,000,000 barrels, or 10.5 percent. Total demand was, therefore, 10.5 percent smaller than in September of last year.

In the first 9 months of 1940, total demand for gas oil and distillate fuel showed an increase of 6.5 percent over that in the like months a year before, with domestic consumption up 18 percent and exports down 38 percent.

The markets absorbed 5.2 percent less heavy fuel oil in September, 1940, than in September, 1939, with both domestic and export business off approximately that percentage. For the first 9 months of this year, however, total demand for residual fuel oil was 3.8 percent larger than in the similar period a year ago, as a 4.6 percent gain in domestic consumption more than offset a 9.4 percent decrease in exports.

Lubricants were required in 21 percent smaller volume in September, 1940, than in September, 1939, as domestic consumption was down 2.6 percent, while exports were off 61 percent. But for the first 9 months of 1940, total demand for lube oils was 3 percent larger than in the like months a year before. Domestic demand was up 3.8 percent, and exports 1.5 percent.

Gasoline Demand Expected to Continue Above Year Ago

SUMMARY OF BUREAU OF MINES FORECASTS FOR DECEMBER, 1940

Barrels

	Forecast December, 1940	Forecast November, 1940	Actual December, 1939	Percent Change for December, 1939–1940
Demand for Motor Fuel*:				
Domestic demand	46,400,000	49,900,000	43,807,000	+ 5.9
Exports	1,800,000	1,700,000	3,136,000	—42.6
Total demand	48,200,000	51,600,000	46,943,000	+ 2.7
Supply of Motor Fuel:				
Straight-run and cracked gasoline production	46,200,000	45,180,000	47,606,000	— 2.9
Natural gasoline used at refineries	4,020,000	4,220,000	4,018,000	+0.05
Total refinery production	50,220,000	49,400,000	51,624,000	— 2.7
Benzol and other natural gasoline	1,180,000	1,300,000	998,000	+18.2
Imports	.....	.....	3,000	.....
Decrease in finished stocks	.....	900,000	.....	.....
Increase in finished stocks	3,200,000	.....	5,682,000	—43.7
Available Supply	48,200,000	51,600,000	46,943,000	+ 2.7
Crude Oil Requirements:				
Percent yield of gasoline from crude	43.00	43.4	44.98	— 1.98†
Refinery crude required	107,460,000	104,100,000	105,835,000	+ 1.5
Daily average	3,466,500	3,470,000	3,414,000	+15.4
Foreign crude runs	3,600,000	3,400,000	2,367,000	+52.1
Exports	3,900,000	3,900,000	4,656,000	—16.2
Fuel and losses	2,600,000	2,500,000	2,548,000	+ 2.0
Total demand for domestic crude	110,360,000	107,100,000	110,672,000	— 0.3
Daily average	3,560,000	3,570,000	3,570,100	— 0.3
Increase in domestic stocks	.....	.....	4,448,000	.....
Actual production	.....	.....	115,120,000	.....
Daily average	.....	.....	3,713,500	.....

*The term "Motor Fuel" as used in this report includes gasoline, naphtha and benzol used for all purposes, but does not include heavier distillates used in the operation of tractors or burned in Diesel engines.

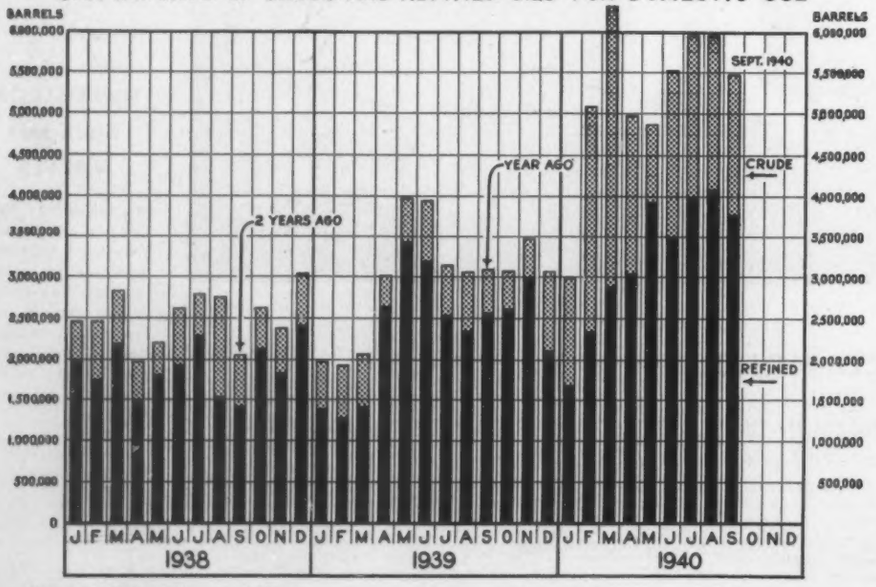
†Indicated decrease in percent yield of gasoline from crude.

Oil Imports for Domestic Use Up Sharply

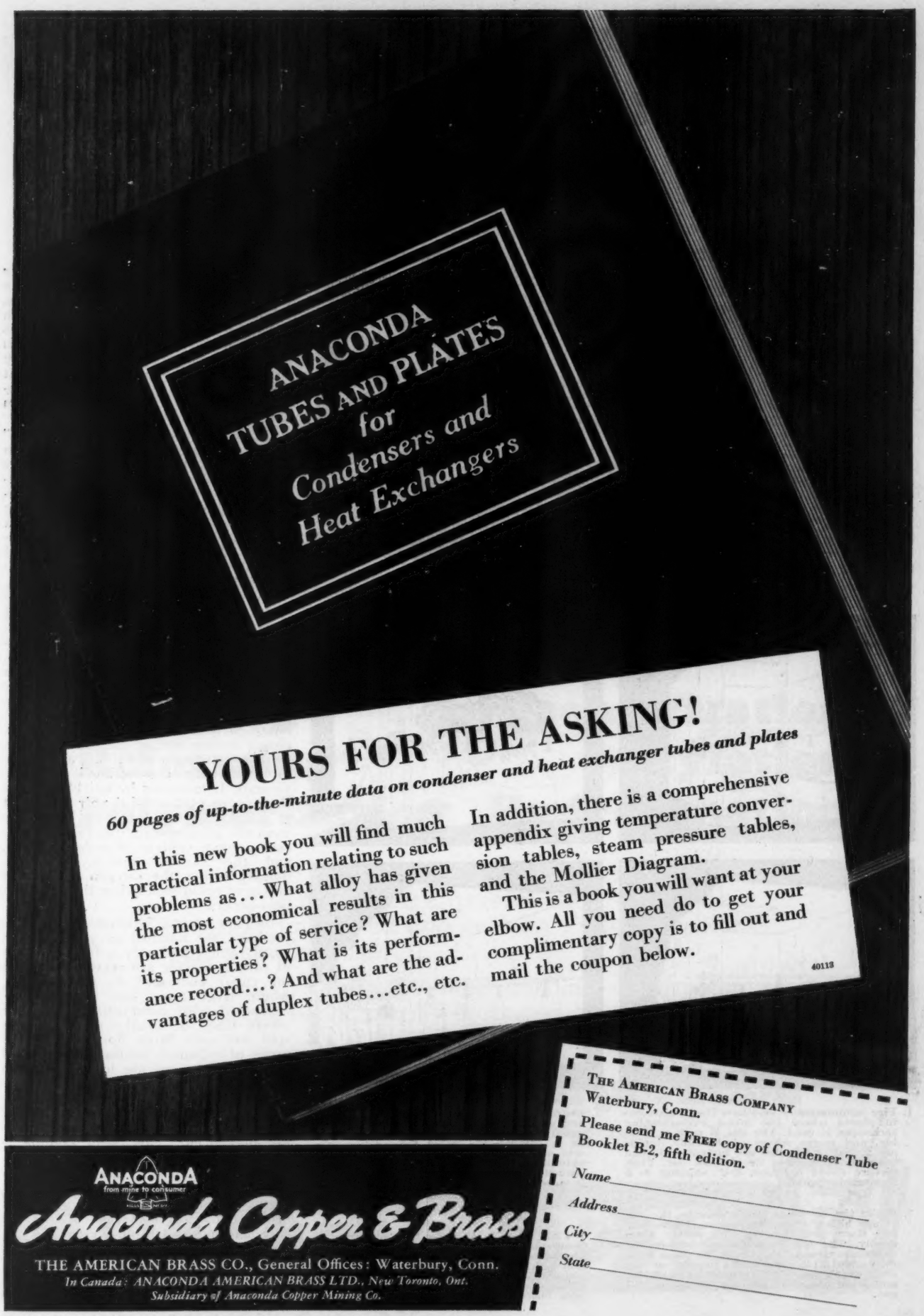
Figures indicate barrels and are from Bureau of Mines.

MONTH	Crude Oil	Refined Products	Total
January:			
Jan., 1939	1,373,000	609,000	1,982,000
Jan., 1940	1,664,000	1,321,000	2,985,000
Change	+21.2%	+117.1%	+52.0%
February:			
Feb., 1939	1,266,000	654,000	1,920,000
Feb., 1940	2,343,000	2,731,000	5,074,000
Change	+85.0%	+320.0%	+164.0%
March:			
Mar., 1939	1,404,000	659,000	2,063,000
Mar., 1940	2,895,000	3,410,000	6,305,000
Change	+106.2%	+417.4%	+205.6%
April:			
April, 1939	2,648,000	366,000	3,014,000
April, 1940	3,041,000	1,948,000	4,989,000
Change	+14.8%	+432.0%	+65.5%
May:			
May, 1939	3,434,000	529,000	3,963,000
May, 1940	3,921,000	934,000	4,855,000
Change	+14.2%	+76.5%	+22.5%
June:			
June, 1939	3,196,000	750,000	3,946,000
June, 1940	3,488,000	2,056,000	5,544,000
Change	+9.1%	+174.1%	+40.5%
July:			
July, 1939	2,539,000	608,000	3,147,000
July, 1940	3,981,000	2,000,000	5,981,000
Change	+56.8%	+228.9%	+90.0%
August:			
Aug., 1939	2,346,000	717,000	3,063,000
Aug., 1940	4,074,000	1,898,000	5,972,000
Change	+73.7%	+164.7%	+95.0%
September:			
Sept., 1939	2,553,000	541,000	3,094,000
Sept., 1940	3,772,000	1,712,000	5,484,000
Change	+47.1%	+216.5%	+77.2%
1st 9 Months:			
1939	20,759,000	5,306,000	26,065,000
1940	29,179,000	17,930,000	47,109,000
Change	+40.5%	+237.9%	+80.7%

U.S. IMPORTS OF CRUDE AND REFINED OILS FOR DOMESTIC USE



Source of Data: Bureau of Mines.



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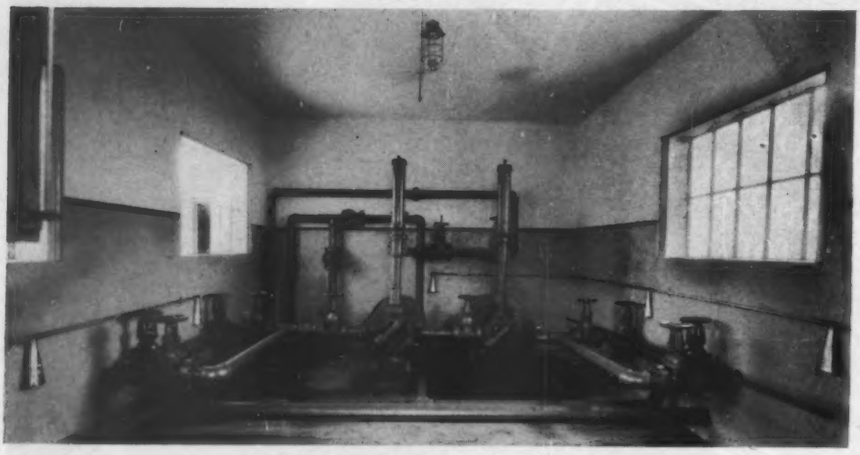
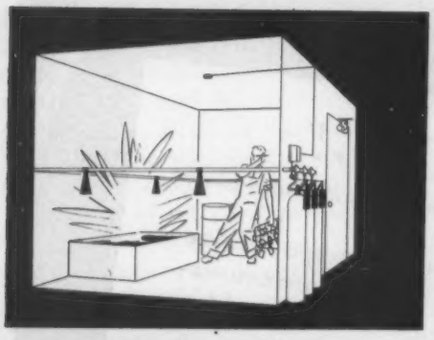
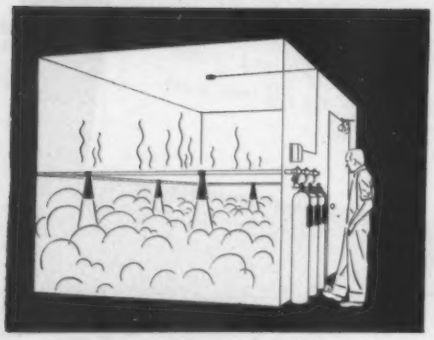


Boiler-Room Installation

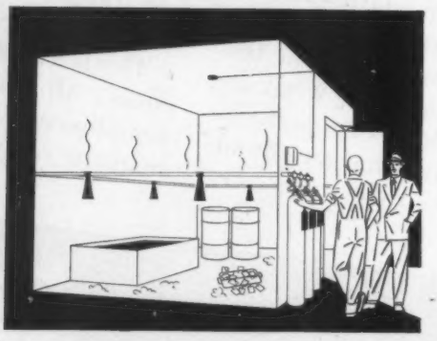


1. Fire automatically smothers itself with gas in plants where the latest extinguishing technique is used. The gas is carbon dioxide, and rooms where combustible liquids are stored or handled are instantly flooded with the gas when fire breaks out. First picture shows a "flash fire" starting in a flammable liquid.

2. Instead of frantic scurrying for hose lines and alarm-boxes, the workman today exits quietly from the burning room. By the time he is outside, the rapid temperature rise sets off the actuator on the ceiling. This automatically releases the valves on the carbon dioxide cylinders, in which the gas is stored at high pressure.



3. While the workman waits outside, the gas clouds billow from the nozzles, blanketing the floor and flooding the entire room evenly. The gas immediately reduces the oxygen content of the air in the room from its normal 21 percent to 14 percent or less —at which point fire cannot burn. Door- and window-closers prevent escape of the gas.



4. It's all over—in 20 seconds. Ventilation is resumed and the non-toxic carbon dioxide dissipates, leaving liquids uncontaminated and making clean-up unnecessary. And, because it is a gas and three-dimensional in action, it penetrates through crevices and past obstructions wherever fire may burn.

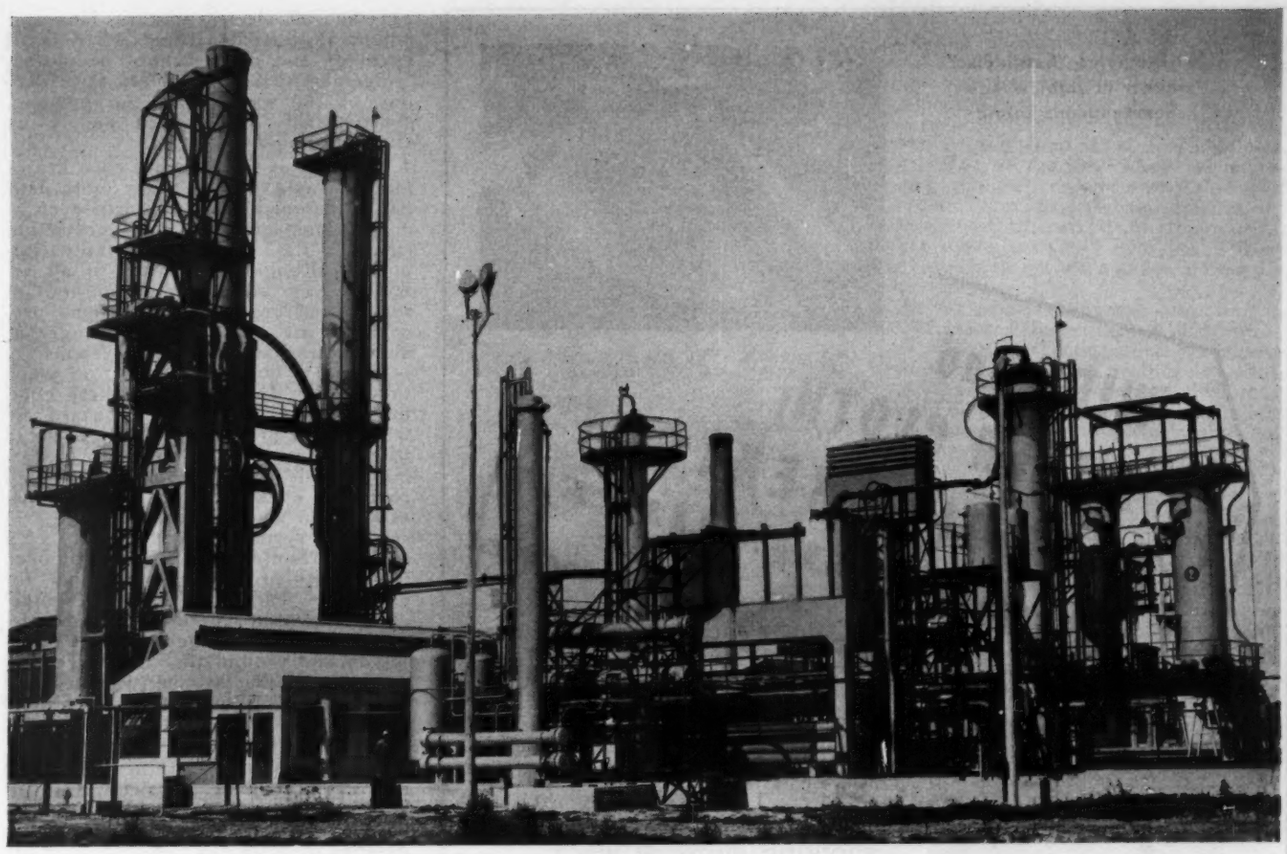
SINCE a large percentage of the fire hazards in refining properties exist in buildings, rooms or other enclosures, safety engineers have devoted much time and thought to controlling this type of blaze. Furthermore, when such fires occur they usually ignite with such speed and burn with such heat that employes cannot get portable fire-fighting equipment in proper position for effective first-aid fire-fighting.

To combat these vicious "enclosed" blazes, engineers have long sought an extinguishing technique for liquid fires that eliminates the human element entirely. Foremost among such techniques is the automatic gas smothering method which takes for granted that a fire will get out of control before employes can muster their forces, and therefore leaves nothing for them to do but retreat to safety.

The gas is carbon dioxide or "dry ice" vapor, and it is stored in liquid form under high pressure in steel cylinders at a point near the hazard. Heat-sensitive detectors are located on ceilings above the hazard or inside of an enclosure, and with a few seconds after fire breaks out, the valves on the cylinders are automatically opened. The liquid carbon dioxide rushes through a piping system and in gas form billows from nozzles into the room where the fire is burning—smothering it in a few seconds. It functions by quickly cutting the oxygen content of the air to a point at which the liquid cannot burn. For example, gasoline requires 16 or 17 percent oxygen content in order to burn, and the carbon dioxide discharge quickly brings the oxygen content of an entire room well below this combustion point.

In some plants, flammable petroleum products are handled or processed in small rooms, and only a few cylinders of carbon dioxide are required to flood the entire enclosure. In other plants, where large areas can become contaminated with combustible fumes or where leaks or breaks can spread a spill fire over large floor areas, batteries of cylinders holding hundreds of pounds of the gas are used. It is also possible to arrange the pipes and discharge nozzles so that the gas clouds envelop only the point in the equipment or the surface of the tank where the fire may occur. This latter method is known as "local application."

In rooms which are completely flooded with the carbon dioxide, automatic closing of doors and windows is provided to prevent escape of the gas. This is done by trip devices in the gas piping, which retract pins when the carbon dioxide rushes through, thus releasing window and fire-door chains. It is also possible to make the released



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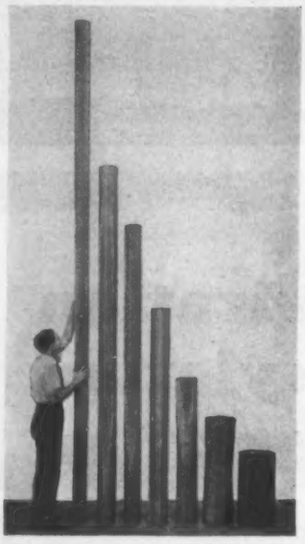

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gas shut off electric motors, fans and pumps in the room, and where wall openings and ducts cannot be closed, "screening nozzles" are used to project jets of the gas across the opening, shutting off the oxygen supply as effectively as a door.

With the ever-increasing volatility of modern fuels there is today more danger of flammable air mixtures even at normal temperatures, and protection against "flash fires" is vitally important. Roughly a quarter of all refinery fires are due to ignition of fumes, and even though extreme precautions are taken against dangerous air mixtures, automatic gas systems are provided to cope with such fires when they ignite. In one plant where combustible air mixtures were a hazard and where flame-propagation could occur in adjoining rooms, 3500 pounds of carbon dioxide is held ready to flood all rooms in event of a flash fire. In another plant where heavier oils are processed, a system with a capacity of a ton of carbon dioxide has recently been installed to protect a single room, for experience had shown that an immediate inert atmosphere is the best safeguard against damage from fire burning in and around the complex equipment used. The system was installed after research showed that one-fifth of all refinery fires were due to leaks, breaks or overheating of equipment.

Most important advantage of carbon dioxide in refinery protection is its ability to move in three dimensions—as does fire—which means that this gaseous medium can penetrate past obstructions that hamper or nullify liquid extinguishing agents. As the gas billows from the nozzles it expands 450 times its original volume, and coupled with the fact that it is slightly heavier than air, this enables it to get into crevices and provide a non-combustible atmosphere in every inch of an enclosure where fire may burn. Overflow fires running down a wall or over the rim of a tank—or fires from broken pipe lines are smothered just as effectively as a fire in a tank. And when the fire is out, there is no clean-up or loss from contamination, for the gas and snow quickly dissipates.

Remote Control For Shutting Down Plant

FOR a shutdown of all plant actvity, Gregg-Tex Gasoline Corporation, in East Texas, placed a master switch outside the plant office. The engines have wiring attached to the magnetos so that they will be rendered inoperative when liquids enter the scrubbers in large slugs. In addition to this set of wiring an additional wire runs to the office and operates on the same circuit. The switch which controls all of the magnetos is operated by hand. By making contact through a small part of an arc, the grounding of the magnetos on all the engines is completed. The object in shutting down the engines by shorting out the magnetos is to prevent gas from being pumped from the field into that part of the plant which may be on fire. The wiring from the circuit in the engine room leads to the mechanical switch through underground conduit, terminating in a control placed on a post conveniently located for operation.

Federal Control Threat Shelved for the Moment

Federal control of the oil industry is considered in Washington as a project to be laid on the shelf, to be dusted off only if federal control of all industry is deemed essential to the defense program or the industry itself becomes unable to cope with the needs of that program for supplies.

Members of the Administration are not at the present time talking about federal control of the oil or any other industry, but it is probable that some time within the next few months President Roosevelt may recommend to Congress the granting of authority to set up a defense resources group of some kind to take over the work now being done by the National Defense Advisory Commission—something along the line of the Taft bill, recently introduced in the Senate.

Rebuffed in every effort to secure control of the important oil industry, Secretary of the Interior Ickes is not likely to renew his drive next year unless conditions materially change, although he told reporters that he believes more strongly than ever that federal control is necessary. Members of Congress have made it clear that they are not in favor of federal control so long as the industry continues a real effort at self-regulation and the producing states keep a tight rein on output.

The Interior head has received but lukewarm support from the President for his plan, embodied in the Cole bill on which a subcommittee of the House Interstate and Foreign Commerce Committee made an exhaustive investigation of conditions in the industry, the results of which are to be embodied in a report probably to be submitted just before the end of the year. While the President, in transmitting Ickes' suggestions to Representative William P. Cole, Jr., for introduction in the House, expressed his approval of the ends sought he has never really "gone to bat" for the measure, and Representative Cole, while sponsoring the bill, has never undertaken strenuously to press it.

Instead, the Maryland Congressman and his subcommittee made an investigation of the industry of equally high caliber as his 1934 study, and is expected to confine his forthcoming report to a discussion of conditions in the industry, with no recommendation one way or the other on the control bill.

It is, of course, impossible to predict what position the President may take next year on the question of industry control, but the impression in informed circles in Washington is that Congress will make no move in that direction until the need for it is indicated from the White House.

Under his emergency powers, never fully interpreted, the President has authority to require establishments to undertake defense work in any cases where tendered government contracts are refused, but there has never been any suggestion that he can dictate to industry under any other conditions. Since the oil industry has volunteered for war work almost to a man and producing, refining and transportation branches are ready at a moment's notice to take on any task which may be necessary for the national defense, the question of forced operation is not likely ever to arise.

The Look Box

There is, however, a feeling in Congressional circles that the present voluntary set-up for the coordination of industrial effort is not the most efficient method which could be devised and that the time is coming fast when it will be necessary to set up a board with fixed authority to control the activities of all industry, not only in order that government requirements may be met promptly but also, in some cases, to limit the non-essential consumption of certain materials and products, to release machinery now used for non-essential production for use in the manufacture of defense needs and to permit the transfer of needed specially skilled labor from non-essential to military work.

Even such a move, however, might have less effect upon the oil than upon many other industries, since there is little non-essential production in the oil industry in the sense of the term in which Administration officials use it. There might be required some contraction of gasoline production in order that more aviation fuel might be secured, but the defense council has not yet determined exactly the extent of the crude reserves of the types from which high-octane gasoline can be produced.

Further, there has been built up in this country a demand for heating oil for household use which can be contracted only at the expense of householders. Equally important is the automobile consumption of gasoline, which can be reduced only at the risk of throwing thousands of filling station workers out of employment and in other ways retarding trade and industry. The Administration is anxious to prosecute the defense program with as little disturbance to normal life as possible, looking ahead to the day when the emergency will be over and new millions of workers, now engaged in defense industries, are thrown out of employment, when every man still in a job will be that much insurance against a new depression.

At the present moment, observers in Washington believe there is little prospect of new energetic efforts to impose federal control on the oil industry. But, they emphasize, different conditions may prevail in a few months or even a few weeks. In other words, they will not make any predictions.

CONVENTIONS

JAN. 6-10	Society of Automotive Engineers, Book-Cadillac Hotel, Detroit.
16-17	Liquefied Petroleum Gas Association, Eastern Section, New York.
FEB. 24-25	Liquefied Petroleum Gas Association, Annual Meeting, Chicago.
Mar. 3- 7	American Society for Testing Materials, Hotel Mayflower, Washington.
APR. 7-11	American Chemical Society, St. Louis.
15-17	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman.
16-18	Western Petroleum Refiners Association, Hotel Arlington, Hot Springs, Arkansas.
23-25	Natural Gasoline Association of America, Baker Hotel, Dallas.
23-25	Petroleum Industry Electrical Association, Mayo Hotel, Tulsa.
25-26	National Petroleum Association, Cleveland Hotel, Cleveland.

Cole Committee To Make Report

Results of the lengthy investigation of conditions in the oil industry conducted by the House Interstate and Foreign Commerce subcommittee will be embodied in a report which will be filed just prior to the convening of the next session of Congress, it was indicated last month by Representative William P. Cole, Jr., chairman.

It is expected the report will be solely factual and will make no recommendations for the enactment of legislation such as the Ickes-written production-control measure, introduced by Cole in July, 1939.

While the investigation, designed to bring the 1934 study of the industry up to date, has been completed for a number of months, the subcommittee's report has been withheld because of a desire not to bring up the controversial question of oil-industry control this session, while at the same time it was not wished to brand as undesirable, either directly or inferentially, a measure which has the blessing if not the active support of the president.

Institute Hears Refining Papers

Refining subjects made up part of the program of the annual meeting of the American Chemical Society, New Orleans, December 2-4.

"Recent Advancements and Applications of the Thermofor Kiln in the Petroleum Industry," was the subject of T. P. Simpson, E. S. Nicholls and J. W. Payne, Socony-Vacuum Oil Company. E. C. Williams, Shell Development Company, discussed process for manufacture of synthetic glycerine by catalysis. Packed columns was presented by L. B. Bragg, Foster Wheeler Corporation. J. W. Packie, Standard Oil Development Company had a general presentation, "Distillation Equipment in the Oil Refining Industry."

"The Application of Rectangular Coordinate Methods to Solvent Extraction," was by J. O. Maloney and A. E. Schubert, Pennsylvania State College. V. G. Skogan and M. C. Rogers, University of Michigan, offered "Estimation of Number of Stages Required in Liquid-Liquid Solvent Extraction in Lubricating Distillates," while "Economics of Design and Operation for Pressure Maintenance and Condensate Recovery," was offered by E. O. Bennett, Continental Oil Company.

December Demand Estimate Lower

The daily average supply of domestic crude oil estimated by the United States Bureau of Mines, to meet the market demand in December, 1940, is 3,560,000 barrels. This is 10,000 barrels below the estimated demand for November, and the actual demand for December, 1939.

Daily average crude production and runs to stills during the five weeks October 5 to November 9 were 3,603,000 and 3,538,000 barrels, respectively. During this period, domestic crude oil stocks decreased an average of 9000 barrels daily, indicating a demand of 3,612,000 barrels.

Large seasonal stocks of gasoline and distillate fuel oil might permit minimum runs to stills during the winter months, but the extent of such curtailment is limited by the indication of a very substantial increase in the domestic demand for all oils during the coming year.

The pressure of foreign oils seeking a market indicates some further shrinkage in exports and substantial increases in the imports of crude and residual fuel oil.

The position of gasoline stocks may be improved by moderate winter additions to storage, by accumulation of defense stocks of aviation gasoline, and by the substantial increase in domestic demand indicated for next year.

The unusual accumulation of distillate fuel-oil stocks, due in considerable part to sharply declining exports, indicates large winter withdrawals from storage and moderate refinery yields. Normal demand may show only a moderate increase over the abnormal demand for heating oils of last winter.

Residual fuel-oil stocks are substantially below the level of last year. A possible sharp increase in domestic demand would require either greater runs than are necessary for other products, increased yields, or larger imports.

Motor Fuel

The domestic demand for motor fuel in December is estimated as 46,400,000 barrels, or 6 percent higher than the actual for December, 1939.

The estimate for exports of motor fuel, based upon forecasts by the principal exporters, is 1,800,000 barrels, or 100,000 barrels higher than the November estimate, but 1,300,000 less than the actual exports in December, 1939.

Stocks of finished and unfinished gasoline on September 30 were 81,907,000 barrels. According to statistics of the American Petroleum Institute, they declined approximately 1,500,000 barrels during October, which would place these inventories at about 80,400,000 as of October 31. If stocks are further reduced by the 900,000 barrels estimated by the bureau for November, they will be approximately 79,500,000 on November 30. The bureau anticipates an increase in finished stocks of 3,200,000 barrels during December.

Benzol production and direct sales of natural gasoline are estimated as 1,180,000 barrels, making an indicated refinery production of 50,220,000 barrels. This is distributed among the various refinery districts as follows: East Coast, 6,730,000; Appalachian, 1,820,000; Indiana-Illinois, 10,540,000; Oklahoma, 3,080,000; Kansas, 2,760,000; Inland Texas, 3,450,000; Texas Gulf Coast, 11,610,000; Louisiana Gulf Coast, 1,280,000; Inland Louisiana - Arkansas, 880,000; Rocky Mountain, 1,320,000; California, 6,750,000.

Crude Petroleum

Natural gasoline to be blended at refineries is estimated as 8 percent of the total refinery production, or 4,020,000 barrels. The yield of straight-run and cracked gasoline is estimated as 43 percent. This yield, applied to the production of 46,200,000 barrels, gives crude runs of 107,460,000 barrels, or 3,466,000 barrels daily.

Runs to stills of foreign crude, which has been showing a steady increase, is estimated as 3,600,000 barrels, or 200,000 barrels higher than the November estimate and 1,233,000 barrels higher than the actual for December, 1939.

Crude-oil exports are estimated at 3,900,000 barrels, the same as the November estimate.

Crude oil to be used for fuel and

Bureau of Mines Forecast of Crude Oil Demand for November

State	Forecast Dec., 1940	Forecast Nov., 1940
Texas	1,277,000	1,291,000
California	593,000	583,000
Oklahoma	422,600	413,000
Illinois	363,600	385,000
Louisiana	280,300	274,000
Kansas	188,400	186,000
New Mexico	100,600	104,000
Wyoming	74,500	75,000
Arkansas	66,100	71,000
Pennsylvania	47,900	45,100
Michigan	47,100	51,000
Montana	19,700	18,900
Indiana	15,500	14,200
Mississippi	13,900	13,800
Kentucky	13,900	12,300
New York	12,100	12,500
West Virginia	9,000	8,500
Ohio	8,000	8,000
Colorado	3,900	3,700
Nebraska	2,000	.....
	3,560,000	3,570,000

Patent Pending

Here's How Flange-Jacks Work: Remove opposite flange bolts, insert jaws of Flange-Jacks in holes and tighten. After removing other bolts, tighten down jackscrews together, separating flanges evenly.

Replace Gaskets EASILY with FLANGE-JACKS

HAS the job of opening flanges on pipe lines for the renewal of gaskets been a "tough one" for you in the past — usually difficult, often dangerous?

Your worries are at an end. Flange-Jacks—a new tool recently introduced by Garlock—makes the replacement of gaskets easy, quick, safe and economical. No more broken flanges, damaged faces, pipe vibration, dangerous sparks or long shutdowns.

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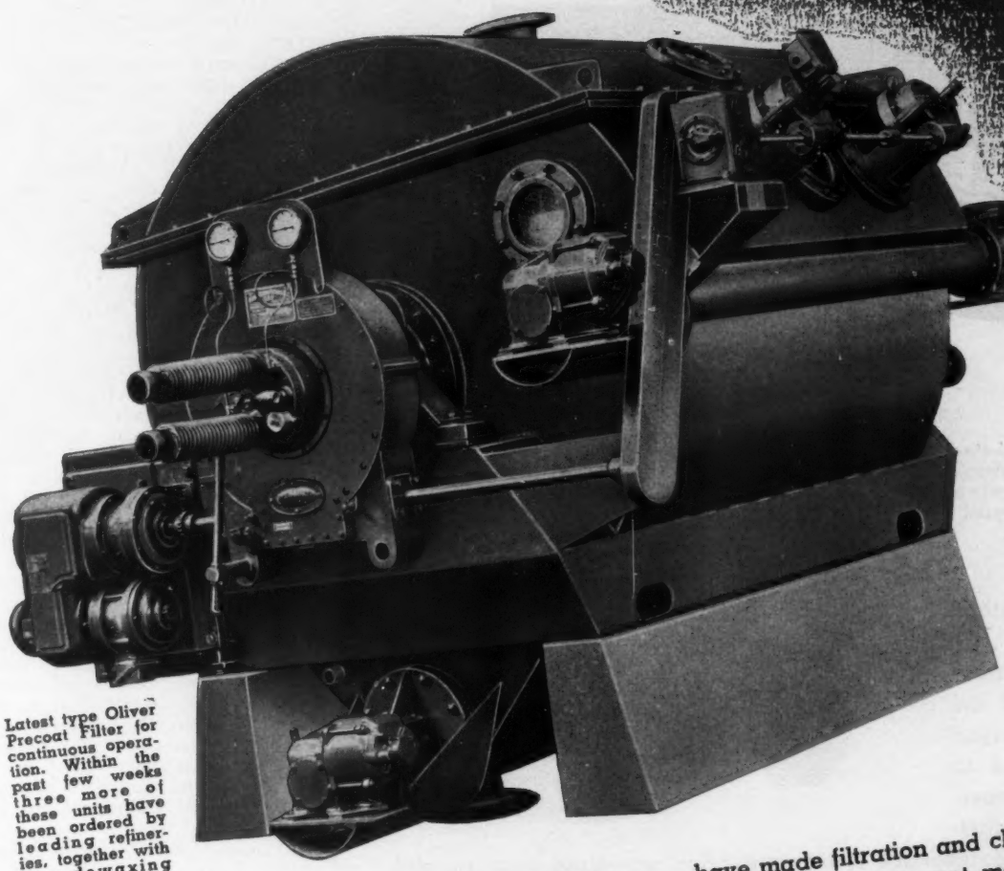

Latest type Oliver Precoat Filter for continuous operation. Within the past few weeks three more of these units have been ordered by leading refineries, together with two dewaxing filters.

Filtration and clarification have always been essentials in refinery operations but with the industry becoming more and more chemical-conscious these will assume even greater importance. New methods and operations requiring filters new to the petroleum industry will find application. These must be specified by engineers thoroughly familiar with the many applications in industrial filtration.

It's a job for specialists—a job for those who have made filtration and clarification their one and only business, not merely an adjunct to some other line.

There can be only one answer—Oliver United. Why? Because we have been building filters continuously for over 30 years and have developed all methods for modern filtration in refineries and other industries; we have many filters from which to select and broadly-experienced engineers to help in the selecting.

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losses is estimated as 2,600,000 barrels.

The total demand for domestic crude oil in December, as indicated by the estimates above, is 110,360,000 barrels, or 3,560,000 barrels daily. Indicated demand, by states, is shown in an accompanying table.

WPRA Meeting Dates Set

Annual meeting of the Western Petroleum Refiners Association will be held April 16-18, 1941, in Hot Springs, Arkansas. The Arlington Hotel will be headquarters. The meeting place was selected after a mail vote of the membership.

The program will be announced early next year.

A.P.I. Storage Group Named

With the selection of three additional national committeemen and the naming of all chairmen and group chairmen of the committee for protection of stored oil and gasoline, the American Petroleum Institute has begun its work toward furnishing recommendations and information as requested by the Advisory Commission to the Council of National Defense. The group will recommend methods for protecting stored products.

Members of the national committee are: W. S. Farish, Standard Oil Company (New Jersey), New York, chairman; H. D. Collier, Standard Oil Company of California, San Francisco; Henry M. Dawes, The Pure Oil Company, Chicago; J. Frank Drake, Gulf Oil Corporation, Pittsburgh; George A. Hill, Jr., Houston Oil Company of Texas, Houston; J. C. Hunter, Mid-Continent Oil & Gas Association, Abilene, Texas; J. Howard Pew, Sun Oil Company, Philadelphia; W. S. S. Rodgers, The Texas Company, New York; W. G. Skelly, Skelly Oil Company, Tulsa; Frank Buttram, Independent Petroleum Association of America, Oklahoma City; C. L. Henderson, Western Petroleum Refiners Association, Wichita; C. L. Suhr, National Petroleum Association, Oil City; D. V. Stroop, American Petroleum Institute, New York, secretary.

Members of the regional committees are:

Northeastern (Army Corps Areas I, II and III), New York, E. H. Barlow, Standard Oil Development Company, Elizabeth, New Jersey, chairman; R. W. Black, Standard Oil Company of New Jersey, Elizabeth, vice chairman; L. M. Bound, Cities Service Oil Company, New York; J. H. Brown, Tide Water Associated Oil Company, New York; W. F. Court, Shell Oil Company, New York; A. E. Esser, Socony-Vacuum Oil Company, New York; Luther Fulton, Pennzoil Company, Oil City; W. H. Goodrich, Walter H. Goodrich & Company, New Haven, Connecticut; W. P. Hayes, The Atlantic Refining Company, Philadelphia; Herbert Henderson, Gulf Oil Corporation, Pittsburgh; M. B. Higgins, The Texas Company, New York; McLean Houston, United Refining Company, Warren, Pennsylvania; Chester Howe, Jenney Manufacturing Company, Boston; A. M. McKean, American Oil Company, New York; H. S. Pettingill, Sinclair Refining Company, New York; Raymond M. Parker, Jr., Hartol Products Corporation, New York, and W. E. Soden, Sun Oil Company, Philadelphia.

Southeastern (Army Corps Area IV), Atlanta—Wiley L. Moore, Wofford Oil Company, Atlanta, chairman; H. A. Grumann, Sinclair Refining Company, Atlanta, vice chairman; L. C. Grosjean, Western Petroleum Refiners Association, Shreveport; Herbert Henderson, Gulf Oil Corporation, Pittsburgh; F. E. Holsten, Chalmette Petroleum Corporation, New Orleans; G. P. Poorman, Standard Oil Company of Louisiana, Baton Rouge, and E. H. Wellemeyer, Cities Service Oil Company, St. Rose, Louisiana.

Great Lakes (Army Corps Areas V and VI), Chicago—L. S. Wescoat, The Pure Oil Company, Chicago, chairman; P. L. Krauel, Standard Oil Company (Indiana), Whiting, Indiana, vice chairman; J. C. Askam, The Ohio Oil Company, Findlay; Paul G. Blazer, Ashland Oil and Refining Company, Ashland, Kentucky; J. C. Bernd, Sinclair Refining Company, East Chicago, Indiana; J. B. Edwards, Socony-Vacuum Oil Company, Detroit; Herbert Henderson, Gulf Oil Corporation, Pittsburgh; R. T. Henderson, Standard Oil Company (Ohio), Cleveland; Wm. F. Krause, The Globe Oil & Refining Company (Illinois), Lemont, Illinois; Stanley Learned, Phillips Petroleum Company, Bartlesville; S. P. Long, Sinclair Refining Company, Chicago; E. C. Rowe, The Texas Company, Lockport, Illinois; E. H. Roy, Cities Service Oil Company, East Chicago, Indiana, and B. Stolley, Shell Oil Company, Wood River, Illinois.

Central (Army Corps Areas VII and VIII), Houston — Hunter, chairman;

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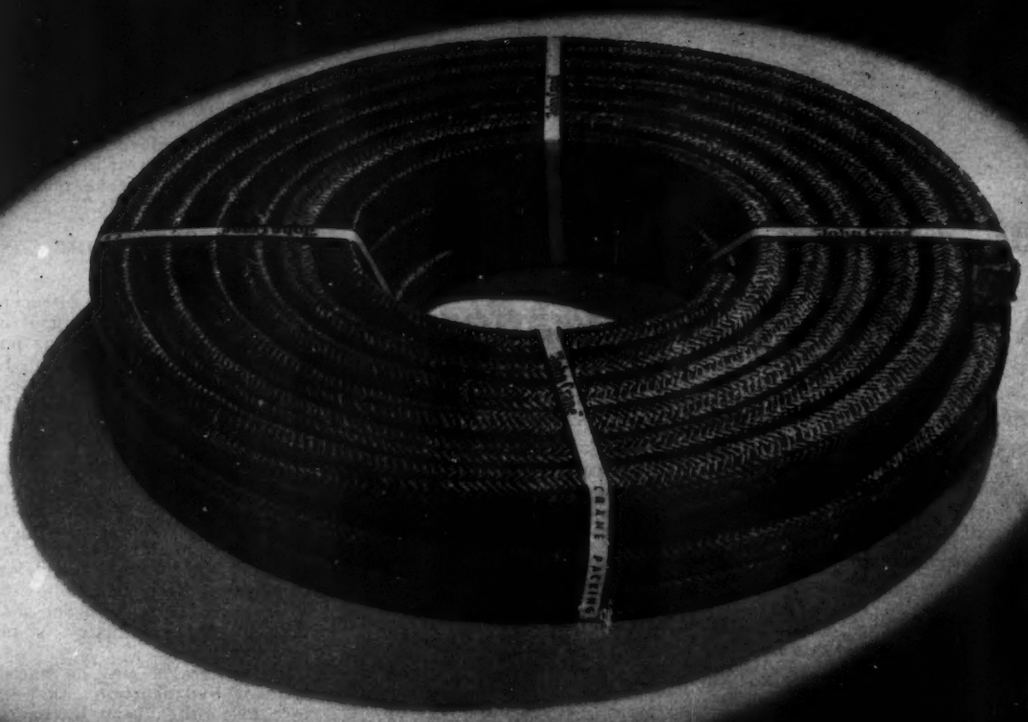

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Western (Army Corps Area IX), Los Angeles—R. A. Sperry, General Petroleum Corporation of California, Los Angeles, chairman; B. A. Moeller, General Petroleum Corporation of California, Los Angeles, vice chairman; W. T. Christman, Petrol Corporation, Los Angeles; G. G. Blanchard, Pacific States Oil Company, Wilmington; David E. Day, Richfield Oil Company of California, Los Angeles; C. E. Finney, Standard Oil Company of California, San Francisco; F. E. Foster, California Oil & Gas Association, Los Angeles; I. M. Hemphill, Shell Oil Company, Wilmington, California; Harvey S. Holloway, Hancock Oil Company of California, Long Beach, California; M. A. Machris, Wilshire Oil Company, Los Angeles; M. V. Moulton, Sunset Oil Company, Los Angeles; A. S. Patrick, The Texas Company (California), Los Angeles; George F. Prussing, Union Oil Company of California, Los Angeles, and H. J. Wilson, Tide Water Associated Oil Company, San Francisco.

How to Protect Plant Property

Because of numerous requests, the Federal Bureau of Investigation, Washington, has prepared a book for the use of industrial executives. It is available through the office of J. Edgar Hoover, director, whose letter to editors gives this:

"In line with this plant survey program and to assist industrial concerns and municipalities in establishing effective protection against possibilities of acts of espionage and sabotage, the FBI prepared a comprehensive booklet entitled, "Suggestions for Protection of Industrial Facilities." Because of its confidential nature, this booklet is limited in distribution to heads of duly constituted law enforcement agencies and executive officials of industrial concerns manufacturing defense materials under government contracts."

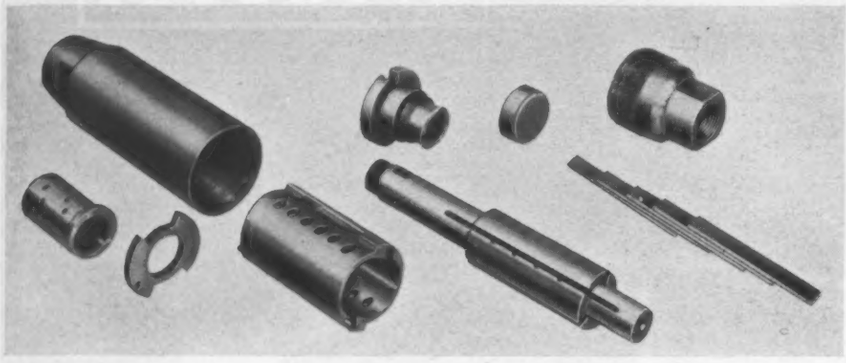
Catalysis, Inorganic And Organic

Although catalysis is of recent adaptation in petroleum refining, it is a study more than 100 years old, as pointed out by authors Sophia Berkman, J. C. Morrell and Gustav Egloff, whose work has been published by Reinhold Publishing Company, 330 West Forty-second Street, New York.

One chapter is devoted to catalysis in the petroleum industry, wherein the several processes for producing high-octane motor fuels, for producing synthetic motor fuels from coal, for segregating the pure hydrocarbons, and for catalytic refining are described.

What the known processes mean to the petroleum industry is thus stated by the authors:

"In general it may be stated that any type of hydrocarbon can be converted into any other type by catalytic reactions already established, and which are adaptable to commercial production. Thus, the foundation has been laid for an improved petroleum industry and for a synthetic chemical industry utilizing petroleum as a raw material for the production of a myriad of synthetic products, which heretofore have been known only as coal-tar derivatives. Dehydrogenation, polymerization, depolymerization, alkylation, isomerization, hydrogenation, cyclization—these are some of the methods by which these products may be obtained catalytically. Simultaneous with the production of commodities useful to mankind has been the development of hydrocarbon chemistry which has furnished chemists with tools heretofore unknown for investigation of hydrocarbon reactions."



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Here are facts about Airetool Tube Cleaners that result in ease of maintenance. Parts are made of carefully selected and hardened alloy steels. They are chosen for long, hard service and they give it. Bearings are best grade bronze. Every part is inspected and tested to make sure it will stand the gaff. In an actual test an Airetool Cleaner outlasted 3 competitive cleaners.

Parts of Airetool Tube Cleaners are accurately ground to a slip fit so that they can be taken down and reassembled without special tools. That saves time on the job.

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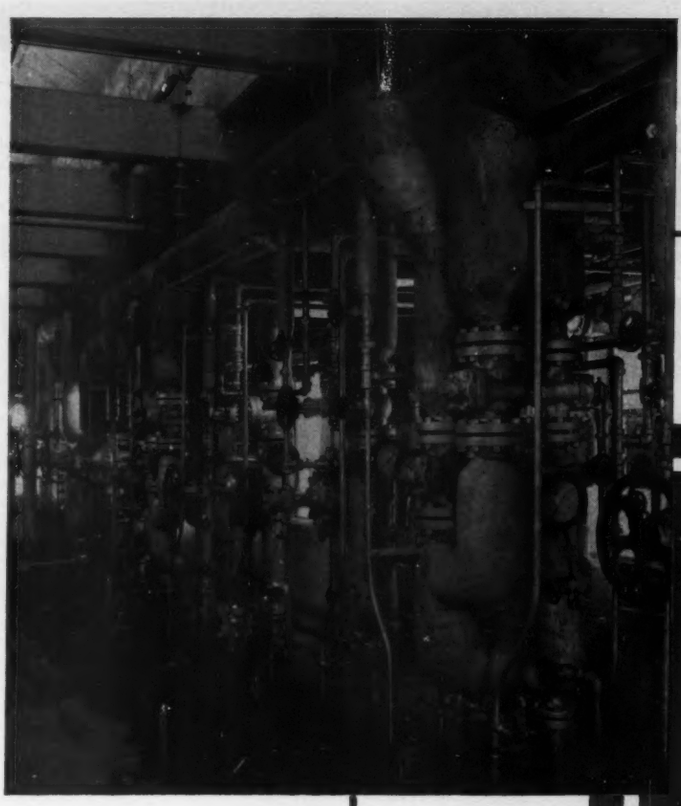

The CHEMICAL ENGINEER COMES INTO HIS OWN

What with the growing use of catalysts and solvents, with the greater use of chemicals and the increasing production of by-product chemicals, it's no wonder that the engineer schooled and experienced in the broad phases of chemical engineering is coming into his own. His services are fully as valuable as those of the engineer whose forte has been, and should continue to be, petroleum.

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Viscosity Determination At Zero Fahrenheit

A method for determining viscosity at zero F., approved by the SAE lubricants division, has been prepared for inclusion in the 1941 SAE Handbook, supplementing SAE lubricants classification. The method was worked out in cooperation with Committee D2 of the American Society for Testing Materials, subcommittee V.

Necessity for providing procedure for the test grew out of adoption of winter oils such as 10-W and 20-W, classifications which are only industry standards, used by both the automotive and the petroleum industries.

Lack of a standard for determining viscosity at zero left many commercial lubricants, which originally met the classification of 10,000 seconds at zero F. in either the rejected class or in the misbranded classification.

The method for testing for viscosity at zero F. as well as a comparison of results with those obtained by use of the old ASTM viscosity temperature chart follows:

"The viscosity at zero F. of engine crankcase oils and transmission and rear-axle lubricants shall be estimated by extrapolation on the ASTM Viscosity-Temperature Charts, ASTM Designation: D 341—39, from kinematic viscosities determined by the Tentative Method of Test for Kinematic Viscosity, ASTM Designation: D 445—39 T, at two temperatures that are at least 60° F. apart (for example, 70° F. and 130° F. or 100° F. and 210° F.), or from Saybolt viscosities determined by the Standard Method of Test for Viscositiy by means of the Saybolt Viscosimeter, ASTM Designation: D 88—38, at 70° F. and 130° F. in the case of low viscosity engine crankcase oils (below SAE 30) and at 100° F. and 210° F. in the case of high viscosity engine crankcase oils and transmission or rear-axle lubricants.

"The error in estimating viscosities at zero F. is cumulative and is far greater than the errors in individual viscosity determinations. Assuming absolute accuracy in extrapolating on the viscosity-temperature chart, an error of ± 0.5 percent in the viscosity determinations at 100° F. and 210° F. may, in the case of an oil having a viscosity of 10,000 seconds at zero F., result in an error of 10 to 15 percent in the estimated viscosity at zero F. To this error, resulting solely from errors in viscosity determinations, must be added the actual error involved in the process of extrapolation, which should not exceed an additional 15 percent. With proper attention to details of procedure outlined in the ASTM methods, the estimated viscosity at zero F. reported by experienced operators working in different laboratories with standardized equipment should not differ more than the amounts shown in the following table:

Estimated viscosity at zero F estrapolated from	Maximum error in estimated viscosity at zero F
Saybolt viscosities determined at 100° F. and 210° F.....	± 20%
Saybolt viscosities determined at 70° F. and 130° F.....	± 10%
Kinematic viscosities determined at 100° F. and 210° F..	± 10%
Kinematic viscosities determined at 70° F. and 130° F...	± 5%

"The estimated viscosity at zero F. determined in accord with the above procedure, may differ from values obtained by extrapolation on the original ASTM Viscosity-Temperature Chart (ASTM Designation: D 341—32 T). For example, an oil having an estimated viscosity of 10,000 Saybolt seconds at zero F. when extrapolated on the original chart from viscosities determined at 100° F. and 210° F. may have an estimated viscosity as high as 12,000 Saybolt seconds when the extrapolation is made in accord with the recommended procedure on the new charts (ASTM Designation: D 341—39). This increase from 10,000 to 12,000 seconds is due solely to the fundamental difference between the old and new viscosity-temperature charts and does not include differences in reported values due to errors in individual viscosity determinations and errors in extrapolating. If the viscosity at zero F. is extrapolated from kinematic values determined at 100° F. and 210° F. or from Saybolt values determined at 70° F. and 130° F. in accord with the recommended practice, the error in the estimated viscosity at zero F. may be as high as ± 10 percent. Therefore, an oil having an estimated viscosity of 10,000 Saybolt seconds on the old chart and 12,000 Saybolt seconds on the new chart may be reported as high as 13,200 Saybolt seconds. If the viscosity at zero F. is extrapolated from Saybolt values determined at 100° F. and 210° F. (this practice is not recommended on account

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of the difficulty of accurately determining Saybolt viscosity at 210° F.), the error may be as high as ± 20 percent and the oil having an estimated viscosity of 10,000 Saybolt seconds at zero F. on the old chart may be reported as high as 14,400 Saybolt seconds without any actual change in the viscosity of the lubricant."

Regional Meeting At El Dorado

At the December meeting of the Ark-La-Tex Division, Western Petroleum Refiners Association, El Dorado, Arkansas, December 6, J. H. Baird, Lubri-Zol Sales Company, Cleveland, discussed, "Engine Varnish as Influenced by Lubricating Oil."

PLANT ACTIVITIES

Recycling Plants: There are now 25 recycling plants for condensate recovery in Texas and Louisiana, with five building and three under consideration. Daily output of the operating plants is 1,000,000 gallons. Plants under construction and under consideration will increase another 700,000 gallons.

Refining Plant Ready: First runs of the new plant of the Wisconsin Oil Refining Company, Sheboygan, were made early in December. Construction of a cracking unit and a polymerization plant will be started in January.

Alkylation at Los Angeles: The Texas Company is planning addition of an alkylation plant at its Los Angeles Harbor refinery for manufacture of 100-octane gasoline. Completion of the unit is expected about March 1. The refinery has a daily crude capacity of 37,000 barrels, with a cracking capacity of 10,000 barrels.

Forest City Basin Plant: Organization of Falls City Oil & Refining Company has been announced by Curtis Flint and Lewis A. Foulger, both of Long Beach, California, and Robert C. Druesdon, of Omaha, Nebraska, to construct a 2000-barrel plant at Falls City, Nebraska.

Canadian Plant Improves: Equipment for producing 80- to 87-octane gasoline is being added at the Calgary, Alberta, plant of British American Oil Company. Demand for the product comes from aviation training operations in Western Canada.

Illinois Natural Gasoline Plant: Warren Petroleum Corporation has completed a natural gasoline plant in the Salem field of Illinois, which is currently producing about 40,000 gallons of gasoline, propane and butanes daily.

Louisiana Plant: Equipment from Mockley Petroleum Corporation's natural gasoline plant at Fry, Brown County, Texas, is being moved to Eola, Louisiana, for use by Anchor Gasoline Corporation. The plant, built by M. E. Mockley for Amerada Petroleum Corporation with 20,000-gallon capacity in 1928, was taken over by Mockley four years ago.

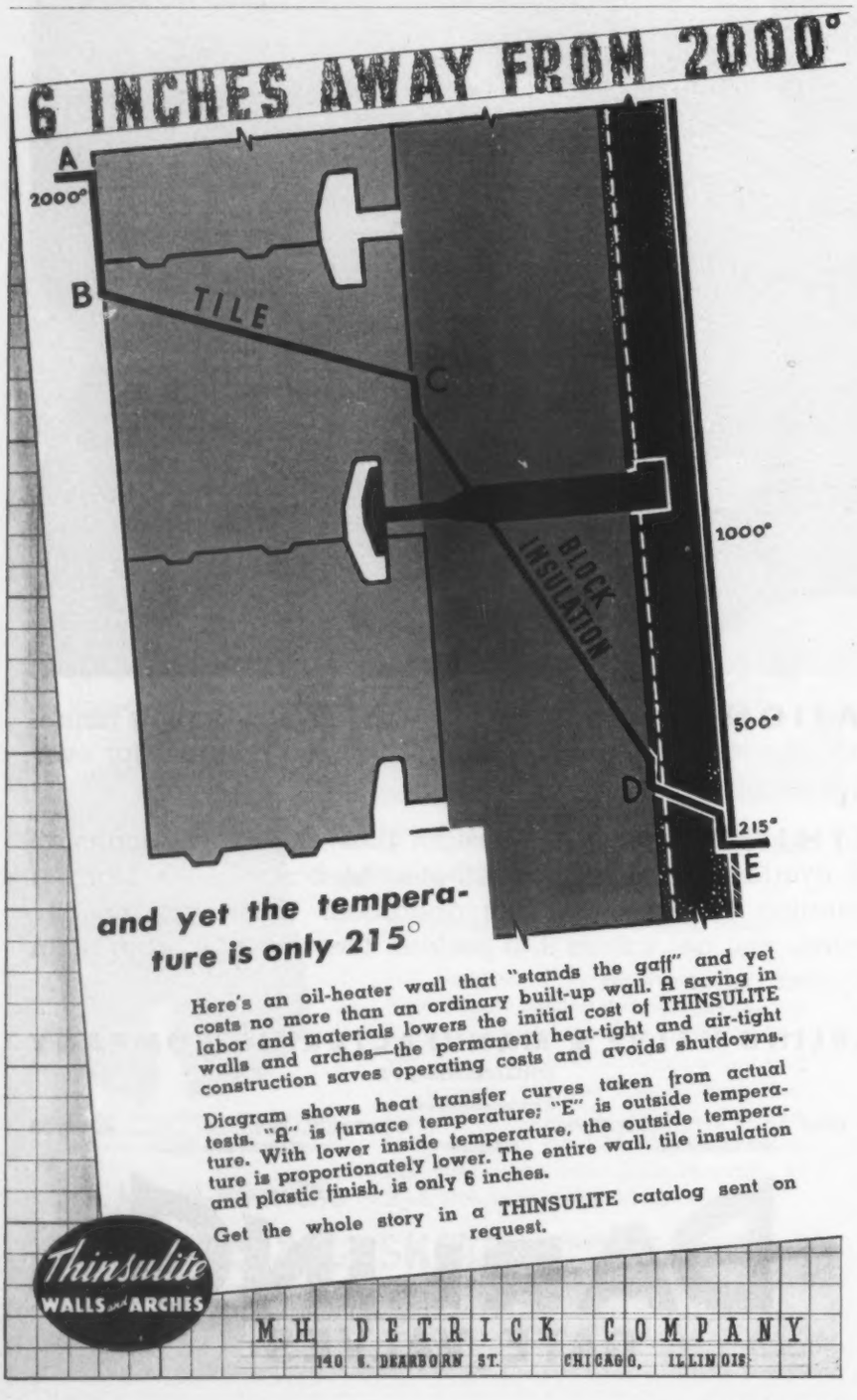
Furnace Distillate Consumption Is Up

Fastest growing market for the petroleum industry is furnace distillate, with a 1939 increase of more than 18 percent. More than 4,000,000,000 gallons of this fuel were burned in that year, which saw home heating burners increase to 2,050,000. The figures are from a report of the United States Bureau of Mines.

Despite the growth, the furnace distillate market has restrictions, chiefly climatic, since three areas of the country are responsible for the greater part of the consumption total.

In addition, heating of buildings and factories took more than 1,600,000,000 gallons of heavy residual fuel oil, and the operation of the millions of small room heaters, range burners in cook stoves, and water heaters consumed 1,500,000,000 gallons of range oil. Total consumption of all these petroleum fuels for heating amounted to 7,278,306,000 gallons, a quantity equivalent to one-third of all the motor fuel consumed in the United States last year. This compared with 6,385,260,000 gallons of heating fuels used in 1938, an increase of 14 percent.

Major reasons for the increase in consumption of the light heating oils were the gain in the number of domestic oil burners in operation and the pronounced colder weather in 1939 compared with 1938. Consumption of light heating oil substantially is proportional to the weather, it has been found.


6 INCHES AWAY FROM 2000°
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2000°
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1000°
500°
D
215°
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and yet the temperature is only 215°
Here's an oil-heater wall that "stands the gaff" and yet costs no more than an ordinary built-up wall. A saving in labor and materials lowers the initial cost of THINSULITE walls and arches—the permanent heat-tight and air-tight construction saves operating costs and avoids shutdowns.
Diagram shows heat transfer curves taken from actual tests. "A" is furnace temperature; "E" is outside temperature. With lower inside temperature, the outside temperature is proportionately lower. The entire wall, tile insulation and plastic finish, is only 6 inches.
Get the whole story in a THINSULITE catalog sent on request.
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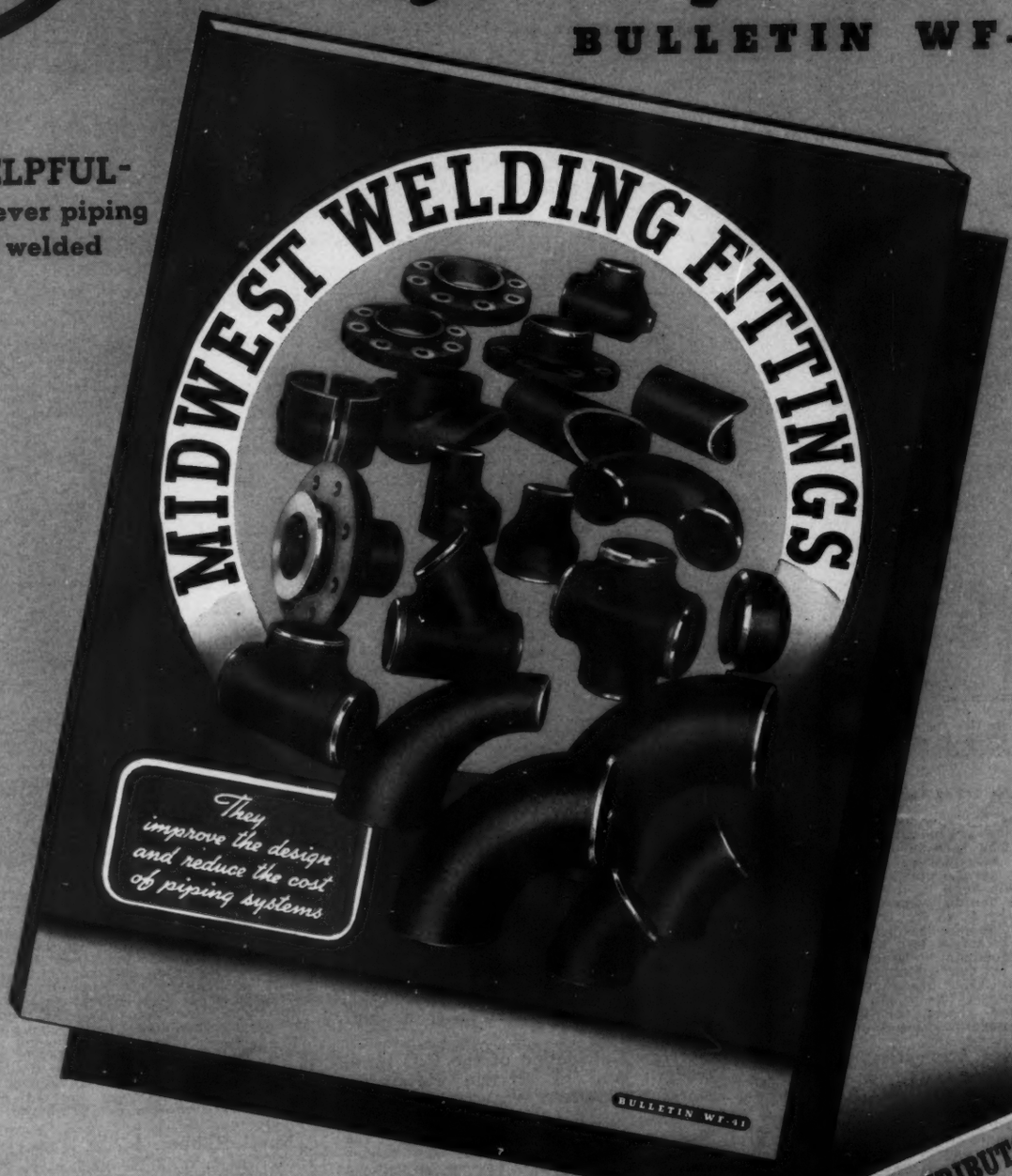

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SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included. Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical And Chemical Data

Boiling Point Relationships among Aliphatic Hydrocarbons, G. EGLOFF, J. SHERMAN, AND R. B. DULL, *J. Phys. Chem.* **44** (1940) pp. 730-45.

The correlation of boiling-point data is important in order that its consistency may be checked and boiling points calculated for those compounds for which data are lacking. The equation $T = a \log (n + b) + k$ reproduces the data within the limits of experimental error. T is the boiling point in degrees K and n the number of carbon atoms in the molecule. The constants a and b are evaluated by the method of least squares from the boiling points of hydrocarbons from ethane to nonadecane, the values of the constants being 745.42 and 4.4 respectively. The values for k are calculated for each series. Testing the equation it was found that the mean deviation between the observed and calculated boiling points for 143 hydrocarbons was 0.7°. This is of the magnitude of the probable error in the data. The difference in boiling points between two successive members of a homologous series is given by the equation

$$T_n = 1 - T_n = 745.42 \log \left(\frac{n + 5.4}{n + 4.4}\right).$$

The difference is dependent only upon the number of carbon atoms and is independent of the series. The introduction of a double bond into the molecule affects the boiling point markedly. In the straight-chain hydrocarbons, a double bond in the terminal position lowers the boiling point, relative to the normal alkane, by 5° to 6°. A double bond in in the 2-position lowers the boiling point less than 0.5°. The effect of two adjacent double bonds in the molecule is illustrated by the boiling points of the 1,2-alkadienes, which boiling points are 8.6° higher than those of the normal alkanes. The triple bond in the terminal position raises the boiling point relative to the normal alkanes about 2.5°.

Gaseous Heat Capacities, II., G. B. KISTIAKOWSKY AND W. W. RICE, *J. Chem. Phys.* **8** (1940) pp. 610-18.

The heat capacities of the lower hydrocarbons were studied by the Lummer-Pringsheim adiabatic expansion method. Theoretical and experimental heat capacities are given for propine, methyl acetylene, cyclopropane, propane, and propylene at temperatures 272, 300, 333, and 368°K. Theoretical and experimental entropies of propylene and propane are compared. The free energy, entropy and heat capacity of cyclo-propane are tabulated for 50° intervals from 100 to 400°K, and at 100° intervals up to 1000°K.

III. *Ibid*, pp. 618-22.

The heat capacities of ethyl ether, dimethyl acetylene and cis- and transdimethyl ethylene were determined. Several procedures were used to correct the experimental data to the ideal gas state.

Solubility of Methane in Cyclohexane, E. P. SCHOCH, A. E. HOFFMAN, AND F. D. MAYFIELD, *Ind. & Eng. Chem.* **32** (1940) pp. 1351-3.

Reference is made to a previous paper in which the authors described an apparatus and experimental procedure for the determination of high-pressure P-V-T-X relations for two-component hydrocarbon systems. The present paper presents data on the methane-cyclohexane system at temperatures of 100.27°, 160°, and 220°F. The solubilities of methane in cyclohexane at pressures up to the critical pressure, and at the foregoing temperatures, are reported in the form of bubble-point data. Specific volumes of the liquid phases, together with their compressibilities up to 6000 pounds per square inch, are also reported. Data are given in detail in tabular form.

Conductivity of Insulating Oils under Alternating Stress, J. B. WHITEHEAD AND BUN PO KANG, *J. Appl. Phys.* **11** (1940) pp. 596-603.

An insulating oil of specific gravity 23.2°Be, flash point 279.4° and dielectric strength 30,000 v. was studied in the temperature range 20 to 100°C. The oil was oxidized and studied after oxidation. The ratios of the initial short time to final steady conductivity ranged from 3 to 5.5. Up to electrical stress of 80 v. per mil the initial short time current was found to be proportional to the applied stress. The dielectric loss at 60 cycles in all instances agreed closely with the loss calculated as leakage loss resulting from initial conductivity.

Nomograph for Paraffin Wax Solubility in Petroleum Fractions, D. S. DAVIS, *Ind. & Eng. Chem.* **32** (1940) p. 1293.

Reference is made to the data of Berne-Allen and Work on the solubility of commercially refined paraffin waxes in petroleum distillates. In view of the evident value of the data and industrial application a nomograph is offered presenting a solution of the equation given by Berne-Allen and Work. The alignment chart as given is extremely open, and permits of easy interpolation along closely graduated scales. The use of the chart is illustrated.

A New Calculation of the C:C Bond Strength and of Certain Resonance Energies, DOROTHY WRINCH, *Science* **92** (1940) p. 79.

Pauling assigns a strength of 100 kg./cal./mol. to the C:C bond. Bond strengths of gaseous ethylene and gaseous propadiene were calculated to be 94.29 and 92.57 kg./cal./mol., respectively. This implies a large increase in resonance energies; benzene at least 17; naphthalene, 28; anthracene and phenanthrene, at least 39.

Manufacture: Processes and Plant

Calculation of Absorber Performance and Design, G. HORTON AND W. B. FRANKLIN, *Ind. & Eng. Chem.* **32** (1940) pp. 1384-8.

The derivation of general absorption and stripping factor equations is presented. No assumptions are involved, and therefore the equations are applicable to all cases of absorption and stripping. A simple rule is presented to estimate the knockout or stripping gradient from plate to plate, and two methods of calculating absorber performance are illustrated. The results of these methods of calculating absorber and stripper performance were compared to plate-to-plate calculations. Although there are discrepancies on intermediate plates, good over-all agreement was obtained between both methods and the plate-to-plate calculations.

Motor Fuels of the Present and the Future, G. EGLOFF, *J. Western Soc. Engrs.* **45** (1940) pp. 79-92.

The tendency in motor fuel manufacture is toward the production of single hydrocarbons or a group of 3 or 4 in order that combustion in automotive engines may be exactly controlled. Motor fuels of 100 octane and over are now produced for aviation purposes. These may be used for pleasure cars within 5 years. These new fuels make the gasoline engine as efficient, or more so, than the best Diesel engines of today.

Studies on the Separation of Paraffin Waxes, Part II—Phase Relationships, M. F. SAWYER, T. G. HUNTER, AND A. W. NASH, *Jour. Inst. Petr.* **26** (1940) pp. 430-451.

It was stated in Part I of the article, previously published, that the only available method for the elucidation of the wax equilibrium diagram involves the separation and analysis of the solid and liquid equilibrium phases formed at temperatures within the melting range of the wax stock. The apparatus for forming the solid and liquid phases and separating them is described in some detail. Experiments in the treatment of a de-oiled slack wax are described. The sweating process, or fractional melting is considered. The ideal process of separation through sweating would involve complete removal of the liquid phase at each infinitesimally small equal temperature increment. In order to construct a fractional melting-process equilibrium diagram the determination of the solid/liquid curves for a one-stage process and for a 14-stage multi-stage process was carried out. The equilibrium diagrams are presented.

Butyl Rubber, R. M. THOMAS, I. E. LIGHTBOWN, W. J. SPARKS, P. K. FROLICH, AND E. V. MURPHREE, *Ind. & Eng. Chem.* **32** (1940) pp. 1283-92.

The authors present what they describe as a thoroughly unorthodox approach to the synthetic rubber problem. The literature of the subject is briefly reviewed, and the considerations stated that led to the developments described. The Esso Laboratories turned to the simple olefins rather than diolefins or more complicated chemical hydrocarbons as the main source of raw material. This is an economic advantage, but also the simple olefins are readily available from refinery cracking plant operations. Because of the abundance of the raw material and its cheapness the process is attractive as a potential supply of synthetic rubber. It is noted that the large residual unsaturation in soft rubber goods is responsible for the pronounced chemical reactivity and susceptibility to oxidative failure. It is also responsible for its lack of resistance to many chemical agents, and to

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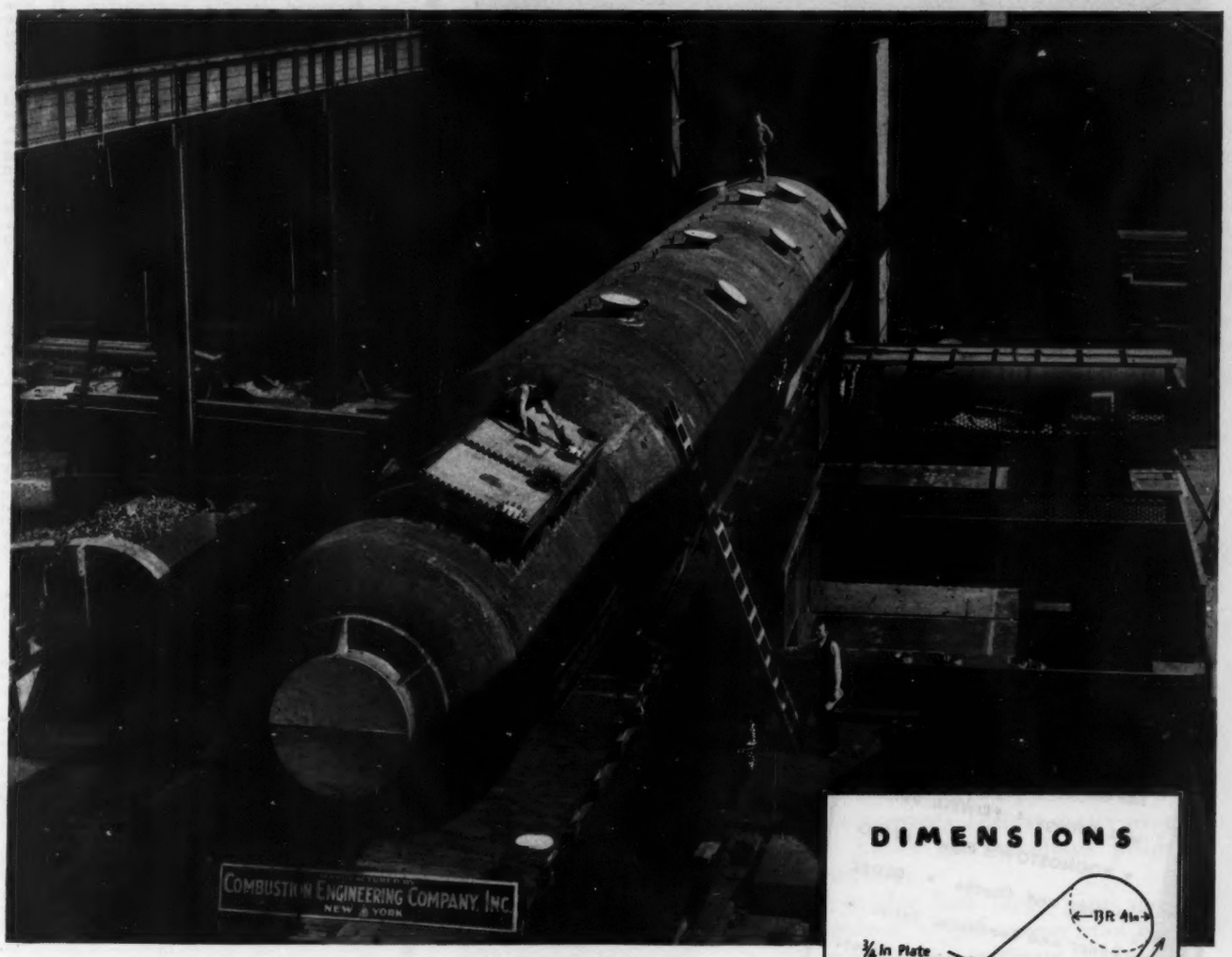

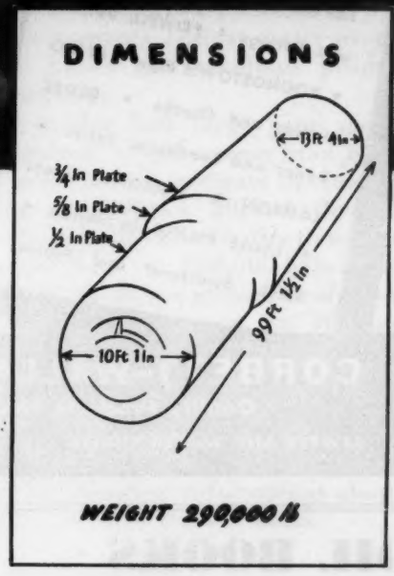

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its lack of heat stability under oxidizing conditions. The problem was therefore approached with the idea of producing a polymeric material having only the limited amount of unsaturation required for vulcanization and no more. Upon completion of the curing such a product should give a rubber with substantially no unsaturation, and therefore with the chemical stability characteristic of a saturated paraffin hydrocarbon. It was found that in spite of this radical difference in internal structure the polymer produced can be processed in much the same manner as natural rubber, and the physical properties of natural rubber have been retained to a surprising extent. Because of the low degree of unsaturation and consequent chemical inertness, butyl rubber, it is believed, will be superior to natural rubber for many purposes. The article presents interesting information on vulcanization, resistance to aging and chemical action, the general procedure in processing, tensile strength, stress-strain relationship, impact cutting resistance, loading and reinforcing, elasticity, hysteresis loss, and compression set, flexing, abrasion, tear resistance, rebound, water-absorption resistance, solvent resistance, electrical properties and gas permeability.

Notes on the Design and Operation of a High Temperature Dowtherm System, R. E. HULME, *Chem. & Met. Engr.* **47** (1940) pp. 685-7.

A Dowtherm system servicing several uses of the vapor at different pressures is described. Among the practical points mentioned are: types of valves that have been found satisfactory, the necessity for steam tracing vent lines to prevent plugging, the use of soft iron for gaskets, the avoidance of scoring of pump shafts through heating to be sure that the Dowtherm is liquid before starting the pumps, and the desirability of flanged and welded joints with avoidance of all ground joints. Deviations from the A.S.M.E. boiler code with reference to Dowtherm boilers are briefly discussed.

Modern Steam Power Generation, D. BROWNLIE, *Chem. & Ind.* **59** (1940) pp. 633-7.

The evolution of modern steam power generation is briefly traced. Until about 1920 the rate of advance was extremely slow and boilers were still in essentials nothing more than natural circulation externally heated kettles. Even the latest forged drum natural circulation water tube boilers for pressures up to 2000 pounds are nothing more than extensions of the old type. In 1922 an oil-cracking chemist, Mark Benson, developed the principle of generating steam under the actual critical conditions of about 3200 pounds per square inch and 700°F. when water is converted into steam without latent heat absorption. The developments in Europe are briefly discussed, following which the author reviews the developments in the United States in the last twenty years. The combination of power generation and use of steam for process work is noted, with reference to a review by Ryan on 85 industrial steam power generation plants using pressures of 500 pounds per square inch or over, in the United States. One of the fascinating developments in the field of steam generation is the work of General Electric on the combined mercury boiler and turbine and steam boiler. This consists of the use of mercury boilers to drive condensing mercury turbines in conjunction with water cooled condensers that also function as high pressure steam boilers with super heaters driving condensing steam turbines. Mention is made of the possible use of Dowtherm in a somewhat similar manner.

Water Supply Equipment in the Process Industries, G. L. MONTGOMERY, *Chem. & Met. Engr.* **47** (1940) pp. 680-4.

The author briefly traces the development of water pumping methods. As a result of the evolutionary process, the vertical deep well turbine pump, because of its relatively high efficiency and trouble free operation, has largely pre-empted the field of well pumping. Vertical pumps may be divided into three classes, including the deep well turbine pump, the mixed-flow pump, and the propeller pump. The propeller pump is designed for delivering large flows of water at low heads. The mixed-flow pump is similar to the propeller pump except that the impeller is modified, so that a pump of this type will produce a pressure head from two to three times that efficiently produced by a propeller pump. In addition to the three types mentioned, volute pumps are used to some extent. Various applications of the vertical pumps are described, as well as a few typical instances of unusual pumping problems that have been solved by their use.

Pipe Line Corrosion Caused by Anaerobic Bacteria, P. GANSER, *Gas Age* **86** (1940) p. 25.

In uncovering gas transmission mains at Upper Darby and at West Conshohocken, the

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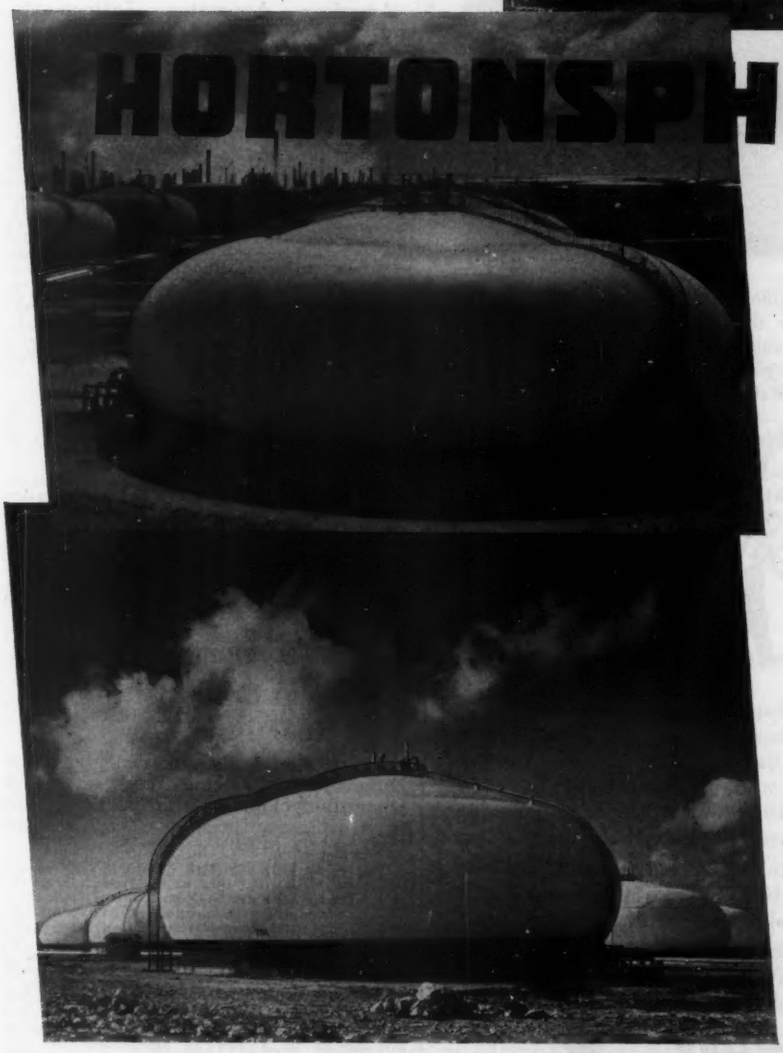

THE illustrations on this page show portions of one of the largest groups of Hortonspheroids ever installed at a single refinery for pressure storage of finished motor fuels. Twenty-two units are used for this service, with a combined capacity of 1,860,000-bbls. More important than the number of units, however, is the ability of every one of these Hortonspheroids to protect its contents against costly evaporation losses and resultant product deterioration.

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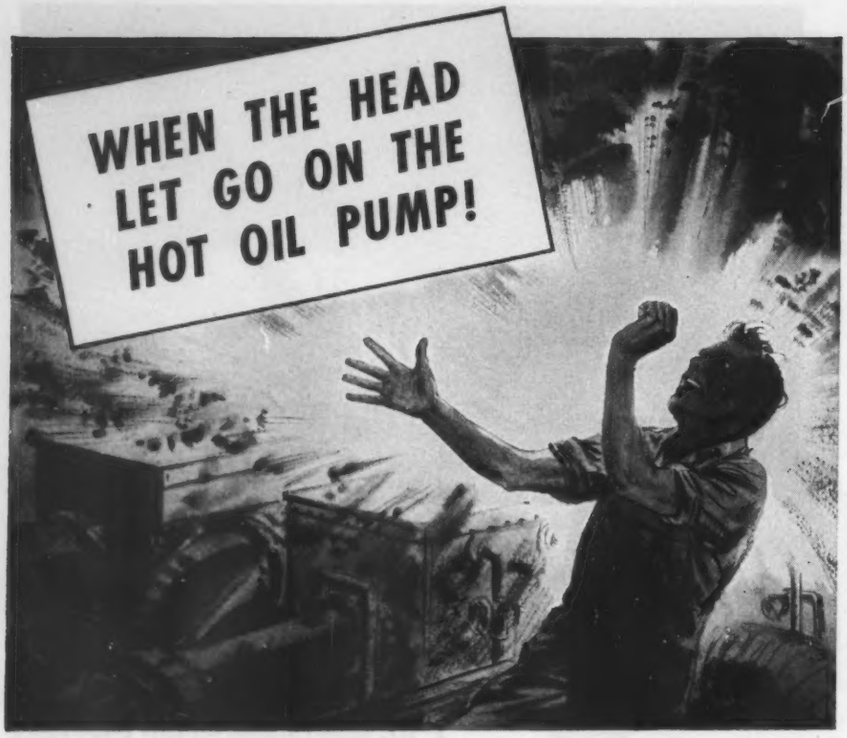

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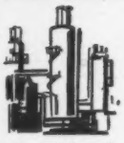

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Philadelphia Electric Company found sections that were severely corroded, presumably from stray-current action. It was shown, however, that the corrosion was caused by the action of anaerobic sulfate-reducing bacteria. Cultures were made of these organisms. Although the bacteria are strictly anaerobic and corrode iron only in the absence of free oxygen, they can survive in aerobic environment for a long time. Sulfate ion, found as calcium sulfate in foul water, can be reduced to hydrogen sulfide by these bacteria. The corrosion product is then ferrous sulfide. If hydrogen sulfide is evolved when hydrochloric acid is poured over the corrosion products it is a definite indication of the bacterial activity of these organisms. For them to work it is necessary that the earth must be saturated with water, that it be air tight, and that the pH of the soil water be between 6.2 and 7.8. If these conditions exist, the degree of attack will depend largely upon the organic foods available near the pipe. As an example, in a pipe line located in a swamp a piece of buried tree was cut away to allow the pipe to pass; when this pipe was uncovered severe corrosion was found for about a foot on either side of the tree. The best method of protection is to construct a box around the pipe and fill it with pitch, thereupon refilling the ditch with good soil.

American Apparatus, Instruments, and Instrumentation, R. H. MULLER, *Ind. & Eng. Chem., Anal. Ed.* **12** (1940) pp. 571-630.

The article is a survey of American instruments and apparatus covering, as the author states, arbitrarily selected fields of measurement and primarily those of importance to the chemist. Among a few of the instruments considered are those connected with the measurement of length and linear displacement, the determination of mass and the operation of weighing, the measurement of time, the production, measurement and control of temperature, high vacuum measurement and control, measurement and control of pressure and flow, electrical and electronic measurements, optical instruments including photoelectric devices, special instruments made of glass, coordinated control of processes, instrumental methods of laboratory analysis, microchemical procedures, general purpose laboratory appliances, and industrial design of instruments. The subject of training in instrumentation is briefly considered.

Tank Content Nomograph, D. S. DAVIS, *Ind. & Eng. Chem.* **32** (1940) p. 1412.

A nomograph is given for the determination of the liquid content of horizontal cylindrical tanks with flat heads. A nomograph was previously given by the author for determining the contents of a partially filled horizontal tank with bumped heads. Although it was possible with the previous nomograph to obtain the volume of flat head tanks, the nomograph given in the present article is simpler for tanks with flat heads.

Chemical Compositions And Reactions

Isolation of 3-Methylhexane, trans-1,2-Dimethylcyclopentane and trans-1,3-Dimethylcyclopentane from Petroleum, A. R. GLASGOW, JR., *Jour. Res. Natl. Bur. Standard* **24** (1940) pp. 509-29.

The fraction of Midcontinent petroleum boiling between 90° and 92°C., from which the aromatic hydrocarbons had been removed, was resolved into its component hydrocarbons. By alternate atmospheric distillation and azeotropic distillation with methyl alcohol the material between 90° and 91.2°C. separated into a paraffinic portion containing approximately 75 percent of 2-methylhexane, and a naphthenic portion. From the naphthenic concentrate, trans-1, 3-dimethycyclopentane was isolated by crystallization from liquid ethane. By means of a similar procedure the material boiling between 91.2° and 92°C. was separated. The naphthenic portion yielded trans-1, 2-dimethycyclopentane, the paraffinic portion, 3-methylhexane. The boiling point, refractive index, freezing point, density, carbon-hydrogen ratio, and critical solution temperature in aniline were determined for the three hydrocarbons. The properties of the hydrocarbons are presented in detail in tabular form.

The Hydrogenation of Petroleum Fractions, Employing a Large Percentage of Catalyst, H. I. WATERMAN AND C. VAN VLODROP, *Jour. Inst. Petr.* **26** (1940) pp. 452-6.

In the examination of hydrocarbon mixtures it is frequently necessary to saturate

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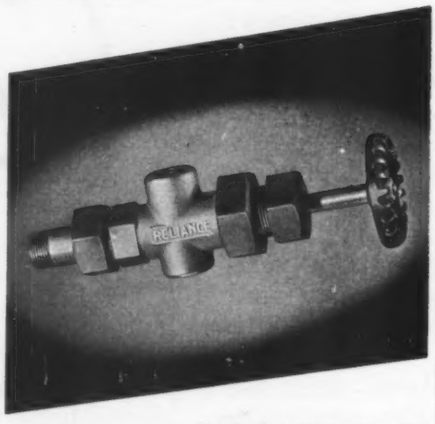

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these mixtures completely by hydrogenation. If the hydrogenation is effected with a nickel catalyst it is in many cases necessary with commercial oil fractions to repeat the hydrogenation treatment several times employing a fresh quantity of catalyst for each treatment. To avoid this a procedure has now been perfected that considerably exhilarates the catalytic hydrogenation under high pressure by using a very large quantity of catalyst such as 100 percent or more. The oil fractions examined showed no decomposition nor objectionable changes in structure. Even dark and asphaltic oil fractions and residues have been converted into completely colorless saturated products by subjecting them to hydrogenation by the new method.

Kinetics of the Decomposition Reactions of the Lower Paraffins. VI. Ethane, E. W. R. STEACIE AND G. SHANE, *Can. J. Res.* **18B** (1940) pp. 203-16.

The decomposition of ethane was investigated at 565-640°C. by the static method. This permitted accurate temperature control and the study of the effect of pressure on the reaction rate. The reaction was effected in a large vessel of approximately 15 liters capacity in order to reduce surface effects and to make sufficient products for analysis. About 200 runs were made. The rate was found to be unaffected by surface. The expression for the rate constant was

$$\log_{10}K = 14.02 - \frac{69700}{2.3RT} \text{ sec.}^{-1}.$$

The reaction products included ethylene, hydrogen, and a small amount of methane and higher hydrocarbons. The value of the activation energy was found to be 69.7 kilocalories, which value is lower than that found by earlier investigators. This indicates that the ethane decomposition must involve long chains if it is a free radical process.

Products: Properties and Utilization

Evaporation Rate of Stoddard Dry Cleaning Solvent, C. S. LOWE AND A. C. LLOYD, *Ind. & Eng. Chem.* **32** (1940) pp. 1310-13.

Distillation curves do not provide adequate information as to the evaporation characteristics of Stoddard solvent used for dry cleaning. The investigation on which a report is made was undertaken to devise a laboratory test that would evaluate evaporation rate of solvents under the conditions of use. It was found that the evaporation rates of commercial dry cleaning solvents vary widely. An apparatus designed by Thorn and Bowman for determining the evaporation rate of solvents at high temperature by passing a measured volume of air through the solvent maintained at constant temperature was utilized in a modified form to obtain evaporation curves for dry cleaning solvents. It was found that the results obtained by using this technique correspond to those obtained in plant practice, or by following the loss in weight of fabrics containing the solvents and suspended in an oven equipped with air circulation. It was also found that the effect of small amounts of fatty acid or mineral oil residues on evaporation rates is negligible.

The Friction of Lubricated Metals, F. P. BOWDEN AND L. LEBEN, *Trans. Roy. Soc.* (London) **A239** (1940) pp. 1-27.

An apparatus was so constructed that the nature and surface finish of the metals, the temperature, load, speed, and atmosphere could be separately controlled. A study was made of the kinetic friction between metals sliding under conditions of boundary lubrication, and also of the frictional behavior of metallic surfaces covered with successive monolayers of lubricant. Among the lubricants studied were mineral oils, fatty oils, primary alcohols, hydrocarbons, and mixtures of these. With the mineral oils and short-chain fatty acids, an intermittent sticking and breaking away of the surfaces occurs through the oil film that may be described as a "stick-slip" motion. However, when the chain reaches a certain length, as with caproic acid, the stick-slip phenomenon disappears and continuous sliding starts. Stick-slips occur with alcohols and with saturated hydrocarbons of the same or somewhat longer chain-length. However, when a small quantity of fatty acid, such as 1%, is added to mineral oil, continuous sliding occurs. When monolayers of lubricants were used it was found that a single layer is highly effective in reducing friction but is quickly removed by wear. Multilayers are more effective. Their rate of wear depends on molecular thickness; the long-chain fatty acids are better lubricants than those with flat, leaf-shaped molecules like cholesterol. The results agree with the view that the frictional behavior and the wear between lubricating surfaces are largely determined by the capacity of the

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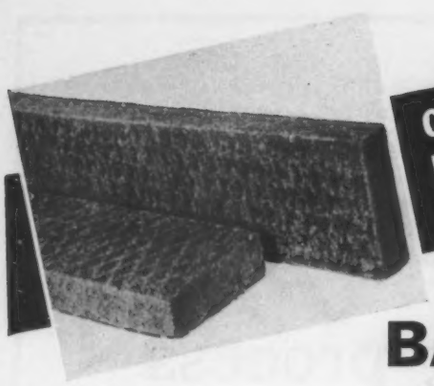

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lubricant film to prevent metallic contact with its attendant intermolecular fields.

Estimating Oil Viscosity at Zero Degrees, *S.A.E. Jour* **47** (1940) p. 17.

The estimation of viscosity at low temperatures is important because of its relationship to the difficulty of starting the engine in cold weather. Since there has been no official method for estimating or determining viscosity at 0°F., a statement was prepared by the S.A.E. Lubricants Division, Subdivision C. in cooperation with A.S.T.M. Committee D2. This has been approved by the S.A.E. Lubricants Division for publication as General Information in the 1941 S.A.E. Handbook. The error in estimating viscosities at 0°F. is cumulative and is far greater than the errors in individual viscosity determinations. If absolute accuracy is assumed in extrapolating on the viscosity-temperature chart, an error of ± 0.5 percent in the viscosity determinations at 100°F. and at 210°F. may, in the case of an oil having a viscosity of 10,000 seconds at 0°F., result in an error of 10 to 15 percent in the estimated viscosity at 0°F. Estimation of the maximum errors that should be had for different methods of viscosity determination are given.

Piston Deposits, Ring Sticking, Varnishing and Ring Clogging, W. A. GRUSE AND C. J. LIVINGSTONE, *Jour. Inst. Petr.* **26** (1940) pp. 413-29.

The two basic changes that cause the formation of engine deposits are: (a) the thermal cracking and coking of the hydrocarbons under essentially non-oxidizing conditions, and (b) the oxidation of the hydrocarbons. With respect to the first, the higher the molecular weight, the greater the carbon residue and the greater the proportion of ring groups, particularly aromatics, the greater the carbon residue. With respect to oxidation, it can be said that the oxidation products of the paraffinic hydrocarbons are acids; on the other hand, aromatic, or partly aromatic hydrocarbons yield resins and asphaltenes. The oxidation products are less stable than the oil, and may also be insoluble in the oil. Among the subjects discussed in the article are: ring sticking, ring-side clearance, condition of cylinder wall surface, reproducibility of pistons, ring-belt temperature, rate of oil consumption, extent of oil oxidation, varnish, oil-ring clogging and sticking, and winter sludging. The article is illustrated with several excellent photographs. It is concluded that engine-varnishing, ring-sticking, and oil-ring clogging are closely related. Oxidation of the oil, chiefly in the crankcase, forming unstable products that decompose at hot points in the engine, play an important part in all three. It is emphasized that crankcase temperatures should be kept as low as possible.

Naphthenic Acids in Specialty Formulas, B. LEVITT, *Chem. Ind.* **47** (1940) p. 166.

The sludges formed in the treatment of petroleum oils with sulfuric acid followed by neutralization with caustic soda are really sodium hydrocarbon sulfonates. In the United States most of the naphthenic acids used are converted to metallic naphthenates for paint dryer. Sodium, potassium and triethanolamine soaps are less alkaline than others, and are good emulsifying and wetting agents and good detergents. They have germicidal and fungicidal properties. Equal parts of carbon tetrachloride, cyclohexanol and sodium naphthenate make a good dry cleaner's soap. Alumina and sodium naphthenate can be used as a sizing material. Aluminum naphthenate removes luster from rayon. Paints can be made that have higher solid content, lower penetration, and that brush more easily. The copper naphthenates are insecticidal, and can be used for protecting wood against dry rot. Zirconium naphthenate can be used in pottery glazes and enamels. Glycerol esters of naphthenic acids can be used in the manufacture of lacquer and wetting agents.

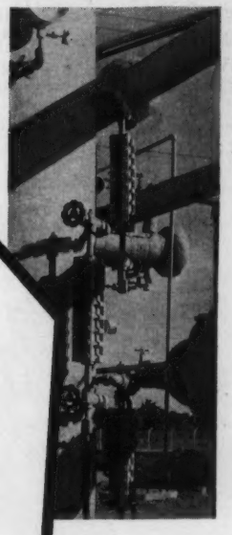
Malcolm G. Vilas, 83, former secretary-treasurer of Standard Oil Company of Ohio, died November 12 in Cleveland. He was retired in 1928. His first work with the company was as a bookkeeper.

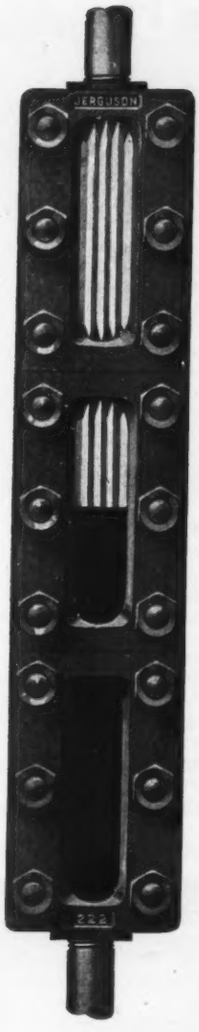
Dr. George Granger Brown, University of Michigan, discussed "Natural Gas Under Pressure" before the Southeast Texas Section, American Chemical Society, Houston, December 6.

J. L. Miller, superintendent of the Houston refining plant of Shell Oil Company, has been awarded a medal designating 20 years of service with the organization.

JERGUSON

Gages





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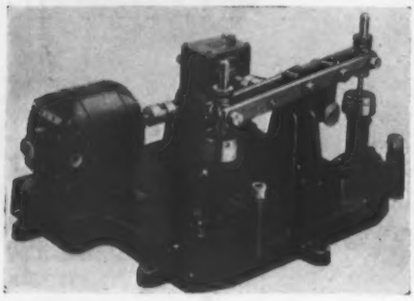
New Equipment for the Modern Plant

Proportioning Pump
HILLS-McCANNA COMPANY

A proportioning pump designed for small capacity at reasonably high working pressures has been announced by Hills-McCanna Company, 2349 Nelson Street, Chicago. It is rated for pressures up to 1200 pounds, and capacities per feed are variable from a few drops per stroke, utilizing a 5/16-inch plunger, to 8 gallons per hour with a ¾-inch plunger.



Hills-McCanna Proportioning Pump

The actuating mechanism embodies a balanced walking beam type rocker arm, hardened steel roller contact points and Oilite type bushings.

Liquid ends are of plunger displacement principle and incorporate outside, vertical composite type check valves, which are available with either single or double suction and discharge. The check valve is designed to eliminate vapor lock and pressure drop through the check, as well as to promote handling of solids in suspension.

The pump is of constant speed, variable stroke type, with capacity variations effected by adjustable plunger buttons. It may be had in single, or multiple-feed assemblies, and standard units can be had with one, two, three or four independently actuated pumping units.

Interval Timer
PHOTOSWITCH INCORPORATED

An electronic interval timer, designated Type T15 and designed for ranges from 1/20-second to 2 minutes, has been announced by Photoswitch Incorporated, 21 Chestnut Street, Cambridge, Massachusetts.

The device employs a snap-action relay of 1000 watts capacity. It is described as flexible with reference to actuating control, permitting both momentary push button and sustaining contacts control. It is universal for six timing ranges represented by timing valves snapped into a clip.

Asphalt Tile
ARMSTRONG CORK COMPANY

An asphalt tile available in 21 colors, described as a grease-proof resilient flooring for areas subject to spillage of oils, fats or greases, has been announced by the Building Materials Division, Armstrong Cork Company, Lancaster, Pennsylvania.

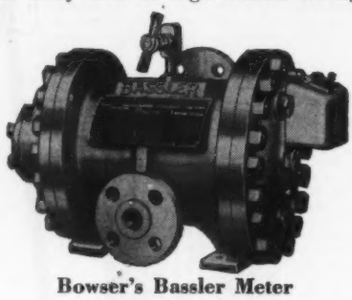
Colors in which the product is available are black, lead gray, Malay brown, Spanish red, dark green, slate gray, tan marble, ebony marble, sea green marble, Burgundy, mulberry, cinnabar marble, saddle tan, light green, white, azure blue, steel gray, travertine, ivory marble, Tennessee marble and indigo.

It is available in 1/8 and 3/16 inch thicknesses, and in the sizes available for regular asphalt tile.

Meter
S. F. BOWSER & COMPANY

A 1-inch Bassler meter rated to withstand pressures up to 1000 pounds per square inch and with capacity 2 to 20 gallons per minute, has been announced by S. F. Bowser & Company, Fort Wayne, Indiana.

The meter measures by reciprocating piston positive displacement. The body is of alloy iron of high tensile strength



Bowser's Bassler Meter

and high resistance to corrosion and abrasion. Interior parts are of iron, steel and bronze, and hold-down pads are cast integral with the body.

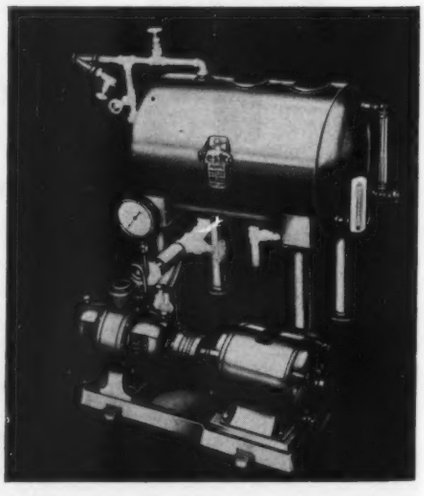
The counter totalizes to 100,000 gallons, or may be had to record in barrels. Thermostatic control can be furnished to compensate for any temperature basis. Air eliminators and sediment strainers are available as accessories.

Boiler Feed System
MICRO-WESTCO, INC.

A boiler return system designed for boilers up to 750-horsepower and 200 pounds pressure has been announced by Micro-Westco, Inc., Bettendorf, Iowa.

The equipment is designed to automatically return all condensate to boiler in both high- and low-pressure equipment, to add made-up water as needed to compensate for loss of live steam, to maintain a uniform water level in boiler, to keep return lines constantly open, and to eliminate back pressure on return lines.

It employs a turbine-type pump hav-



Micro-Westco Boiler Feed System

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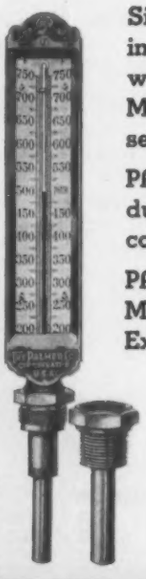

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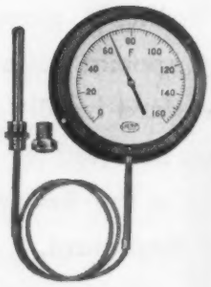

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See detailed data, page 261, 1940 Refinery Catalog

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KEEPING RETURN BENDS OFF THE REPLACEMENT REQUISITIONS

Return bends in an oil refinery can be either a direct aid to economical operation or a constant drain on the maintenance account. Into which classification they fall depends on the service they give and the frequency with which they appear on replacement requisitions.

Return bends made from 4-6 per cent Chromium-Molybdenum steel qualify in the first category. The steel has good corrosion resistance and retains its strength at elevated temperatures. The Molybdenum content eliminates temper brittleness.

All three qualities are important from the service standpoint, the last named particularly so. It means that bends can be safely cooled to ambient temperatures before removal for cleaning.

Chromium-Molybdenum is one of several Molybdenum steels which are demonstrating their value in day-after-day refinery operation. Complete data on them is contained in our book, "Molybdenum in Steel", a copy of which will be sent free on request to those interested in improved materials.

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ing renewable liners. Over-size shaft and bearings, with bearing adjustment for centering impeller, are designed to prevent galling and seizing and to offer further protection against excessive maintenance expense.

An automatic boiler water-level control starts and stops the boiler feed pump to maintain the water level in the boiler within a ¾-inch range, cuts off the burner or stoker if the water in the boiler reaches a dangerously low level, and sounds an alarm when the low water cut-off point is reached. Control is fitted with a Monel float, has bellows to eliminate packing, and is constructed with all operating parts isolated from steam and the hot-water zone.

Packing

CRANE PACKING COMPANY

A plastic packing with tape back reinforcement vulcanized to its outer surface, providing a non-frictional surface to bear directly against the moving part, has been announced by Crane Packing Company, 1800 Cuyler Avenue, Chicago.

The packing is described as sufficiently pliable to be bent around small-diameter rods and shafts without fracturing or cracking, or to be formed into small rings without distortion. It is a dry-graphitized plastic packing of long-fibre asbestos, anti-frictional metal particles and binders. It contains no oils that maybe driven off by heat or pressure,

Crane's Plastic Packing

and is described as flowing easily under gland adjustment.

Designed for centrifugal and rotary services, including centrifugal feed pumps, low-pressure steam rods, valve stems, centrifugal pumps, rotary pumps and expansion joints, the packing is available in six styles: for general service, air, water, steam or mild chemicals where temperatures do not exceed 550° F.; for superheated steam, hot oils and hot gases where temperatures run higher than 550° F.; for oils, petroleum distillates and solvents with temperatures up to 550° F.; for foods, fruit juices and edibles; for chemicals, caustic alkalies and acids, and for superheated steam or gases where temperatures do not exceed 750° F.

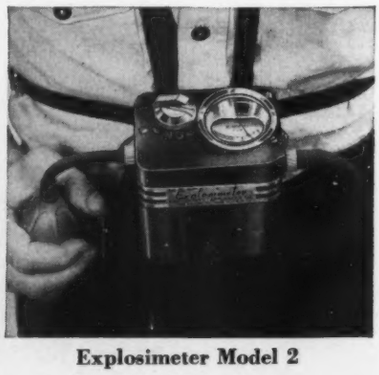
Each type is available in sizes from ¼- to 1-inch, graduated by sixteenths, in coils, standard-length spirals or in die-formed rings, or sets to stuffing-box dimensions.

Gas Indicator

MINE SAFETY APPLIANCES COMPANY

A combustible gas indicator, designated Model 2 Explosimeter and employing an electrical circuit featuring a single filament and single control knob, has been announced by Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh.

The instrument may be operated with one hand, leaving the other free to handle sampling line or probe. Response to combustible gas concentrations is provided by meter, with the reading obtained on the second squeeze of the bulb when a 5-foot sampling line is employed. The flow system is cast integral with case, and a built-in filter chamber is provided to trap dust and moisture. The filter chamber will also accommodate a



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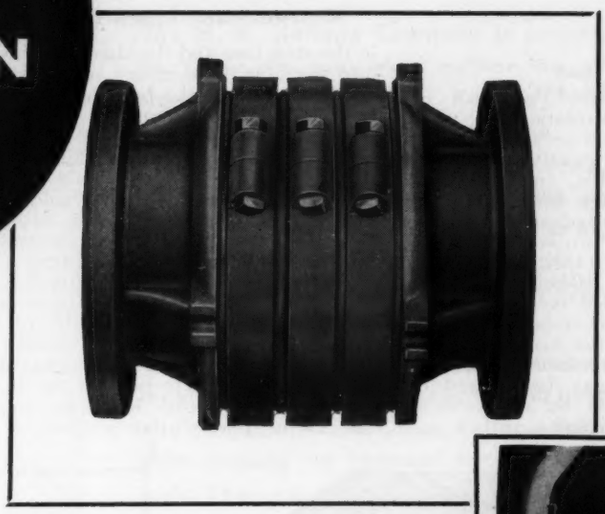

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They solve these high temperature expansion problems because the Directed Flexing stainless steel corrugations will function perfectly up to even 900° F. They solve them because stainless steel will withstand the corrosive conditions usually prevailing. They solve them because being the corrugated type, they are packless.

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Less visible, perhaps, but fully as important is the scientific heat-treatment given every Badger Expansion Joint. This assures durability. Bulletin 100 gives complete details.

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Badger Non-Equalizing Expansion Joints, illustrated in the small picture at the right, are ideal for serving as connections between turbines and condensors, between pumps and lines, and other places where vibrations and limited expansions under low pressures must be absorbed. Bulletin 200 discusses these expansion joints.

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charcoal cartridge for proper differentiation between illuminating gas and condensable, combustible vapors such as gasoline.

The meter is powered by standard flashlight batteries contained in a compartment separate from the working parts to preclude possibility of electrolyte from discharged cells affecting electrical controls.

An on-off signal bar on the control knob is raised prominently in view when current is turned on, and drops flush with the knob when current is switched off, to prevent the user from unknowingly leaving the instrument with current on.

The replaceable single filament is described as having a normal useful life of several thousand tests, and a spare is contained in the case, ready for instant use.

Nitridation

DREVER COMPANY and INDUSTRIAL STEELS, INC.

A process for nitridation of parts made of stainless steel or stainless iron has been announced jointly by Drever Company, Philadelphia, and Industrial Steels, Inc., Cambridge, Massachusetts.

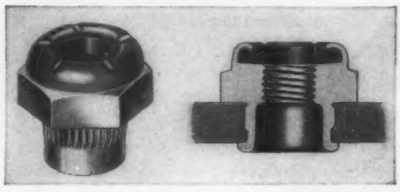
Designated Drever-Industrial stainless nitriding process, it provides a glass-hard, 89-93 Rockwell 15N, abrasion-resistant case 0.002- to 0.028-inch thick on the surface. The case is described as having superior wear-resistant properties and practically the same corrosion resistance as the unnitrided material, with surface that may be ground or polished without loss by abrasion or loss of corrosion resistance.

Lock Nut

ELASTIC STOP NUT CORPORATION

A self-locking nut with knurled shank, designed for fastening sheet-metal assemblies in which the parts must be readily removed and returned to position, has been announced by Elastic Stop Nut Corporation, 2332 Vauxhall Road, Union, New Jersey.

To install the nut, a hole is drilled



Knurled-Shank Clinch-Type Nut

in the structure and the shank is pressed into the hole. The mouth of the shank is spread against the back of the structure to effect a clinching hold. The knurling engages the drilled surface to assist in eliminating any turning of the nut.

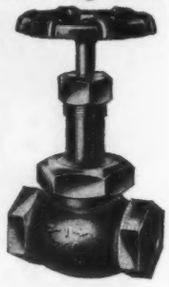
The nut head is fitted with vulcanized fiber collar, unthreaded, and designed to resist entrance of the screw and to automatically take up all thread play and bring the load-carrying thread faces of the nut and screw into a tight pressure-contact. As the screw thread impresses its way through the collar, the pressure is maintained and increased to a degree designed to prevent the screw from working loose. Resilient character of the fiber collar is intended to make possible removal and replacement of the screw without loss of the locking action.

The nuts are available in a complete range of sizes, thread systems, shank lengths and materials.

Valve

READING-PRATT & CADY DIVISION

A new bronze glove valve with a full plug-type seat and disc and designed for throttling services on high-temperature and high-pressure steam lines, has been announced by Reading-Pratt & Cady Division of American Chain & Cable Company, Reading, Pennsylvania.



The valve is also intended for use on high-pressure lines carrying boiler scales and other gritty substances which act on seating materials. The body is of a hard bronze, disc and seat is of heat-treated stainless steel of 500-Brinell hardness, and stem is high strength wear-resisting bronze.

Coupling

FARREL-BIRMINGHAM COMPANY

A flexible coupling, designated Manger and designed for connecting a shaft directly to a flywheel, brake drum or flange without use of a dummy, pilot or stub shaft, has been announced by Farrel-Birmingham Company, Ensonia, Connecticut.

In design, compensation for misalign-

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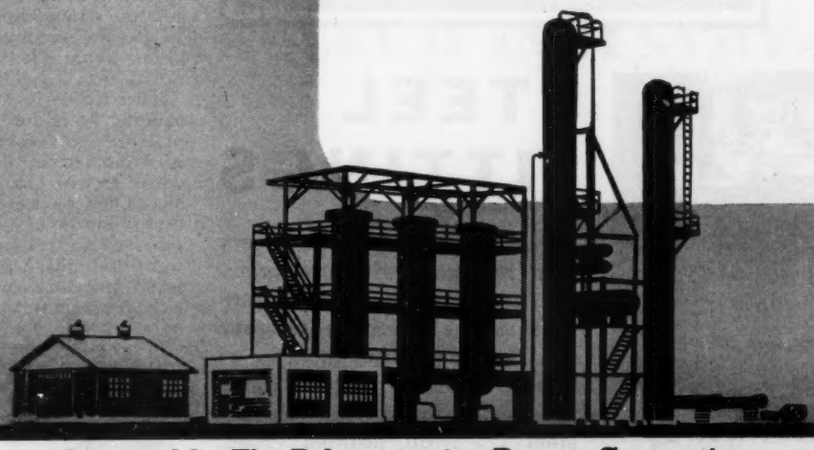
The M. W. Kellogg Company is prepared to show the individual refiner the economic advantages of a Kellogg-Polyco Catalytic Polymerization installation.

Utilization, by the refiner, of his cracked gases is becoming a necessity. More gasoline per barrel of crude run, and a high octane blending-stock for motor fuel, are advantages that deserve the refiner's careful consideration.

Kellogg-Polyco Units incorporate equipment simple in design, inexpensive to install and easy to operate. Often, Kellogg-Polyco Units require no increase in supervision costs. They are the solution to many problems faced by the refiner today.



Licensed by The Polymerization Process Corporation

KELLOGG

LICENSING AND CONSTRUCTION AGENTS under United States and foreign patents for:
Catalytic Processes for Cracking, Reforming, Dehydrogenation, Alkylation, Desulphurization

- Gasoline Products Company, Inc., Pyrolytic Cracking
- The Polymerization Process Corporation, Thermal and Catalytic Polymerization
- JUIK Processes for Lubricating Oil Refining with Propane and Phenol Deasphalting · Dewaxing · Solvent Extraction and Acid Treating Plants
- The Gray Processes Corporation, Clay Treating

THE M. W. KELLOGG COMPANY • JERSEY CITY, NEW JERSEY • 225 BROADWAY, NEW YORK

Los Angeles: 609 South Grand **Tulsa: Philtower Building**

EUROPEAN REPRESENTATIVE: Compagnie Technique des Petroles, 134 Boulevard Haussmann, Paris, France.

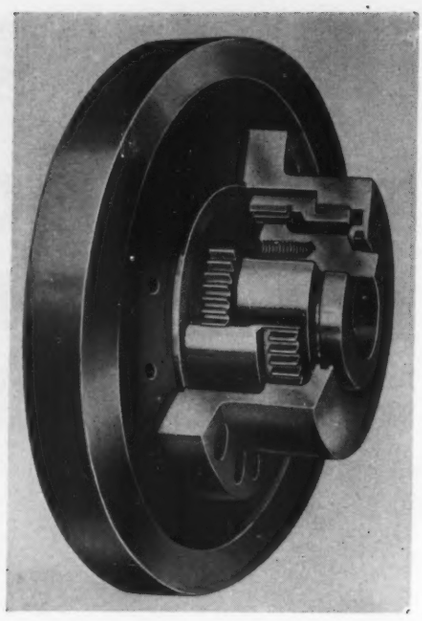
ment is made by an internal sleeve which floats between an externally geared hub and an internally geared covering sleeve. The internal sleeve, which engages the hub and outer sleeve, is free to slide and rock, adjusting for differences in alignment. The driving member of the coupling may be either the geared hub or the covering sleeve.

External gear teeth are crowned to give freedom to the floating sleeve within the design limits of the coupling. Compensation is provided for offset, angular and combined misalignment without resistance to free lateral float of the connected shafts.

The device is described as equally applicable for connecting two free-ended shafts in combination with a solid, flanged, half coupling to give a close-coupled connection. When two units are coupled to a single driver, it is possible to operate one unit by unbolting the coupling and drawing back the outer sleeve on the unit which is not to be used. The hub of the driver is solid, and there are no loose parts to interfere with free rotation of the driving shaft.

In connecting shafts of different diameters, the coupling is mounted on the smaller shaft and bolted to a rigid, flanged, half coupling on the larger shaft. The size of the flexible member is determined by the size of the smaller shaft, permitting use of a smaller coupling.

Applications for which the unit is recommended include connecting a shaft to an engine flywheel, connecting one shaft to another that carries an overhung brake drum, connecting shafts of different diameters, connecting driving shaft to roll or pinion stand when radial clearance is insufficient for a standard coupling, and in combination with a magnetic or pneumatic clutch coupling.



Farrel-Birmingham's Manger Coupling

Interval Timer

THE R. W. CRAMER COMPANY

An interval timer designed for control of industrial equipment which may be automatically timed, designated Model D2, has been announced by The R. W. Cramer Company, Centerbrook, Connecticut.

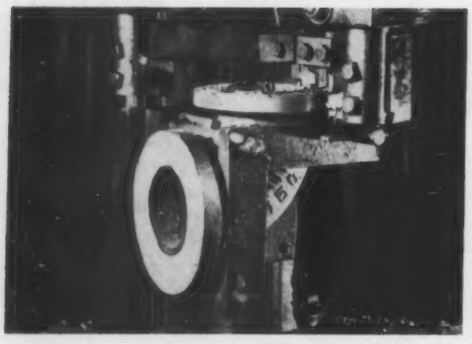
It employs a standard self-starting synchronous motor driven interval timer enclosed in a dust-tight splash-proof cast aluminum housing arranged for conduit connection and provided with a full-vision window and external setting knob. Front view light signals are optional.

The timer is available in 12 scales, ranging from one revolution in 15 seconds to one revolution in 24 hours. Dial is 3 inches in diameter and features white etched characters against a black enamelled background. A non-clouding type window of unbreakable material is recessed and gasketed to provide a dust-tight and splash-proof enclosure. An inward pressure on the knob assembly engages a clutch for setting the timer,

R. W. Cramer's Interval Timer

Quality Control from Start to Finish is a part of all...

BEAIRD



STEEL FITTINGS

In the huge Beaird plant every care is taken to insure precision in each fitting, from pattern to the final hydro-static test. Beaird features include ... heavier walls of uniform thickness . . . finest acid electric steel . . . all flanges faced, turned and backfaced. An ample stock is maintained for immediate shipment.

WRITE FOR BULLETIN No. 50-A . . . and you will have all features and specifications in concise, understandable form. Do this NOW!

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SHREVEPORT, LA.

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PATENT LICENSES IN THE PETROLEUM INDUSTRY

TEXACO DEVELOPMENT CORPORATION

A Subsidiary of The Texas Corporation

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and when released, a spring and gasket prevent entrance of moisture around the control shaft. The housing is provided with two ½-inch threaded conduit openings.

Fintube

BROWN FINTUBE COMPANY

A fintube designed with fins welded to the tube to provide one-piece construction for maximum structural strength and heat-transfer ability, has been announced by Brown Fintube Company, Elyria, Ohio.

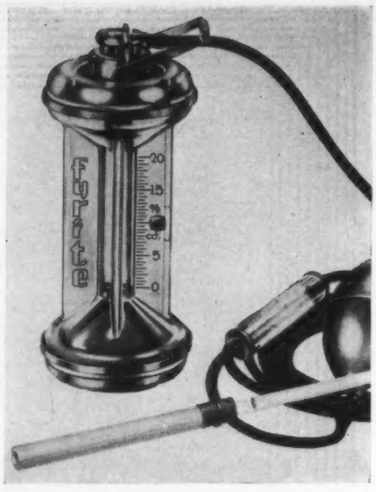
Fins are applied longitudinally to allow for longitudinal flow of fluids on the fin side. The equipment is available in 42 sizes, and in low-carbon steel, stainless steel, and steel tubes lined with non-ferrous liners.

CO_2 Analyzer

BACHARACH INDUSTRIAL INSTRUMENT COMPANY

A chemical-type analyzer for measuring the percentage of CO_2 in the flue gases of boiler furnaces has been announced by Bacharach Industrial Instrument Company, 7000 Bennett Street, Pittsburgh. Designated Fyrite, the device includes a primary flue filter with a replaceable filtering thimble.

In operation, a flue gas sample of known volume is pumped in the instrument by hand with a rubber bulb, and trapped in the instrument by pulling off the sampling hose. The instrument is turned upside down and back again to mix the gas sample with the absorbing reagent, described as good for several hundred samplings before replacement is required. The suction created



Bacharach CO_2 Analyzer

due to absorption of the CO_2 pulls the absorbing fluid up an amount equal to the CO_2 absorbed, its level showing the percentage of CO_2 in the gas. The entire operation is described as taking less than a minute.

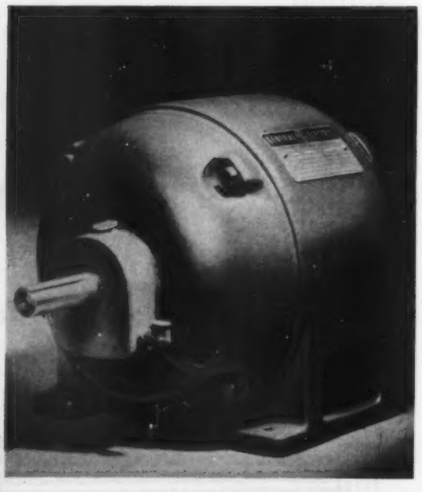
The instrument is a plastic molding, transparent and compact in design.

Polyphase Motor

GENERAL ELECTRIC COMPANY

A line of polyphase motors, designated Tri-Clad and incorporating a cast-iron frame, advances in insulation of current-carrying parts, improved bearing design and lubricating arrangements, cast-aluminum rotor, and pressure-relief system of greasing for ball-bearing motors, has been announced by General Electric Company, Schenectady, New York.

External form of the motor provides openings for entrance of exit of cooling air in the end shields and cast frame to provide a greater degree of protection against entrance of falling liquid or particles. Improved air deflectors and fan designs coupled with double-end ventilation, contribute to lower motor temperatures. Air is drawn into both ends of the motor to impinge immediately against the coil extensions. Integrally cast rotor fans draw low-velocity air through openings in the lower portion of each end shield. Use of



General Electric's Tri-Clad Motor

WILSON TUBE CLEANERS
FOR EVERY REFINERY TUBE
WHETHER LARGE OR SMALL
For the speedy, safe and satisfactory removal of exceedingly hard or thick coke or scale or heavy gummy deposits from refinery tubes and pipes Wilson EP (Extra Power) Series Tube Cleaners, illustrated above, are unexcelled.
Designed especially for refinery use, these cleaners develop from 30% to 75% more power but use from 25% to 40% less air than ordinary tube cleaners of the same size and thus reduce "down time" and tube cleaning costs.
Write for the name of our representative nearest to you or send for a copy of our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.
THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
47-28 37th Street
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STOCK FORM PLACARDS Ready For Delivery

4 Inches
4 Inches
Keep
AWAY
From FIRE,
HEAT and OPEN-flame
LIGHTS
CAUTION
LEAKING Packages Must be Removed to a Safe Place
DO NOT DROP
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS.

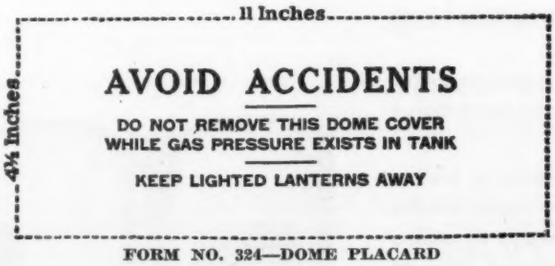
RED LABEL FOR INFLAMMABLE LIQUIDS
(Reduced Size)
FORM NO. 322—Actual size
4 x 4 inches

Tanks must be loaded with outlet valve cap off and valve must not permit more than a dropping of liquid. Inflammable liquids must not be loaded into domes of tank cars. Manhole covers and outlet valve caps must be securely closed and be tight against leakage and suitable gaskets must be used. A tank car that leaks or that has not been properly tested and marked, must not be used for the transportation of an inflammable liquid.
INFLAMMABLE
KEEP LIGHTS AND FIRES AWAY
HANDLE CAREFULLY
This car must not be next to a car containing Explosives. Do not enter with exposed flame, nor with lighted lantern, until car has been ventilated and vapors allowed to escape.
When lading requiring this placard is unloaded from cars, THE PLACARDS MUST BE REMOVED OR REVERSED

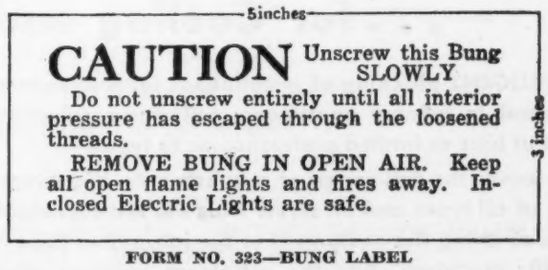
FORM NO. 320—INFLAMMABLE PLACARD
(Reduced Size)
Actual Size 10¾ x 10¾ inches

Tanks must be loaded with outlet valve cap off and valve must not permit more than a dropping of liquid. Inflammable liquids must not be loaded into domes of tank cars. Manhole covers and outlet valve caps must be securely closed and be tight against leakage and suitable gaskets must be used. A tank car that leaks or that has not been properly tested and marked, must not be used for the transportation of an inflammable liquid.
INFLAMMABLE
GASOLINE
KEEP LIGHTS AND FIRES AWAY
HANDLE CAREFULLY
This car must not be next to a car containing Explosives. Do not enter with exposed flame, nor with lighted lantern, until car has been ventilated and vapors allowed to escape.
When lading requiring this placard is unloaded from cars, THE PLACARDS MUST BE REMOVED OR REVERSED

FORM NO. 321—INFLAMMABLE PLACARD
(Reduced Size)
Actual Size 10¾ x 10¾ inches


11 Inches
4½ Inches
AVOID ACCIDENTS
DO NOT REMOVE THIS DOME COVER WHILE GAS PRESSURE EXISTS IN TANK
KEEP LIGHTED LANTERNS AWAY

FORM NO. 324—DOME PLACARD


5 inches
3 inches
CAUTION Unscrew this Bung SLOWLY
Do not unscrew entirely until all interior pressure has escaped through the loosened threads.
REMOVE BUNG IN OPEN AIR. Keep all open flame lights and fires away. Inclosed Electric Lights are safe.

FORM NO. 323—BUNG LABEL

Form No.	Size	Binding	PRICE PER M 1,000	5,000	10,000
320	10¾x10¾ inches..	Loose placards....	$5.45	$4.95	$4.50
321	10¾x10¾ inches..	Loose placards....	5.45	4.95	4.50
	Placards quoted F.O.B., Houston, Texas				
322	4x4 inches.....	Pads of 100 sheets.	$4.00	$3.60	$3.25
323	5x3 inches.....	Pads of 100 sheets.	3.00	2.70	2.45
324	4½x11 inches.....	Pads of 100 sheets.	3.50	3.15	2.85

The Stock Placards shown in reduced sizes are all printed on paper stocks and sizes as specified by the I.C.C. regulations applying to transportation by rail in freight service on inflammable liquids. We will send samples and prices on these placards at your request.

GULF PUBLISHING COMPANY . . . HOUSTON, TEXAS

large, smooth air passageways and baffles are designed to increase cooling efficiency by control of air direction, velocity and discharge through openings in the frame just above the motor feet.

Formex magnet wire is employed, the design permitting elimination largely of older type paper, cotton coverings and other fibrous materials which absorb moisture. Windings are given an application of a synthetic-resin varnish and covering coat of Glyptal red. The motor coils, after winding, are given a coat of improved synthetic resin varnish, and then given a final coating of Glyptal No. 1201 red, and alkyd-resin material designed to provide a moisture-, acid-, oil- and arc-resisting surface.

The sleeve bearing utilizes hard-tin babbitt centrifugally cast into a steel shell, and is locked in a dust- and oil-tight enclosure by a removable pin.

Other features include a wide conduit box to simplify installation in close quarters and which may be mounted in any one of four positions; clearly marked terminals to permanently identify the leads; reversible stator to permit the conduit box to be located on either side and up or down on side-wall mounting; ball-bearing motors can be operated vertically or mounted on a side wall; end shields that may be easily changed to any one of four positions on the job, and an oil-filler gauge that may be located on either side.

The same assembly of shaft and rotor is used on many sizes of both sleeve- and ball-bearing motors, permitting conversion of many sleeve-bearing motors to ball-bearing by changing only end shields, bearings and caps. Similarly, ball-bearing motors can be converted to sleeve-bearing if precautions are taken to prevent damaging the journals when removing ball bearings.

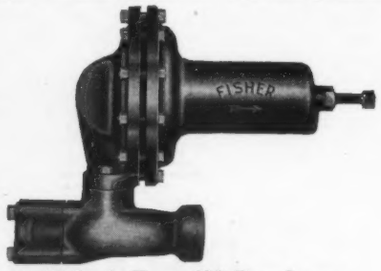
A single spare rotor less bearings can be used for both ball- and sleeve-bearing motors. End-shield cap screws are located on a 45-degree angle to permit accessibility in removing and reassembling the end shields. Knock-off lugs are provided to aid removal of the end shields.

Regulator

FISHER GOVERNOR COMPANY

A new regulator for high and intermediate gas pressure reduction, designated Type 630, has been announced by Fisher Governor Company, Marshalltown, Iowa.

Design of the valve permits automatic maintenance of reduced pressure



Fisher's Type 630 Regulator

at a set point regardless of fluctuations in inlet pressure and increases in demand load. Diaphragm assemblies for reduced pressure ranges of 0 to 30 pounds, and 25 to 150 pounds, respectively, are available, and are interchangeable on all sizes.

Sizes available are 1-, 1¼-, 1½- and 2-inch, with three orifice sizes, ¼-, ⅜- and 1-inch. They are designed for inlet pressures up to 1000 pounds per square inch and for reduced pressure range of 2 to 150 pounds per square inch.

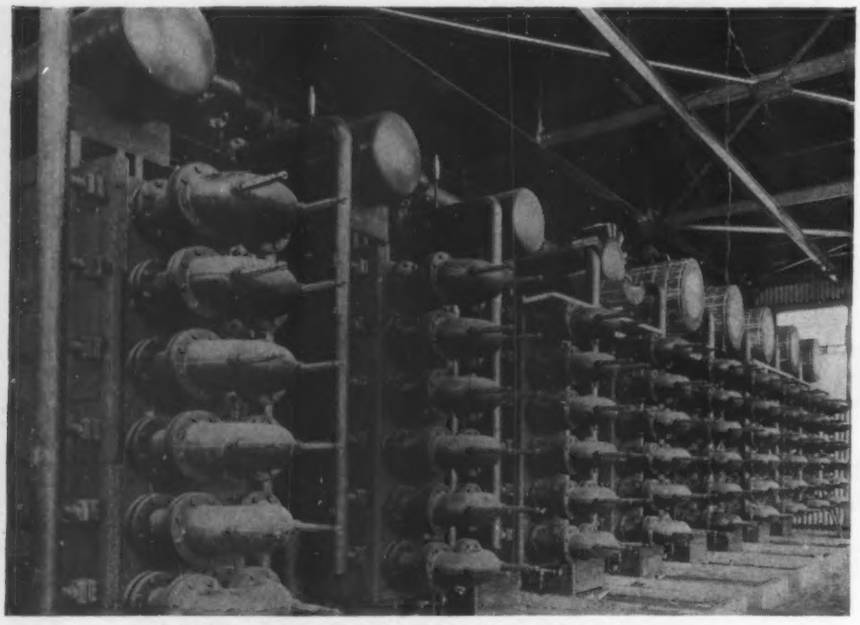
First Aid Kit

E. D. BULLARD COMPANY

A new cylindrical first aid kit equipped with a wall bracket which allows removal for transfer to a scene of emergency has been announced by E. D. Bullard Company, 275 Eighth Street, San Francisco.

A canvas roll-up, containing unit

Bullard's Cylindrical First Aid Kit



Bank of nine Worthington-Carbondale double-pipe chilling machines used in the oil solvent dewaxing process. Photo taken during construction.

LOW TEMPERATURE REFRIGERATING EQUIPMENT ... for Cooling and Dewaxing

INTELLIGENT planning of installations for precise temperature and capacity control in refinery operations, calls for a selection of equipment items without bias or limited preference as to type.

To cover the full range of requirements, Worthington-Carbondale builds units of all types and all sizes. Thus our recommendations are made on the basis of fitting the equipment to the job, rather than finding ways to utilize specific machines. And the petroleum engineer who familiarizes himself with this equipment can obtain from Worthington-Carbondale exactly what he needs to meet any set of conditions.

● ***Descriptive literature is available on all of these products. Write for the items in which you are interested.***

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WORTHINGTON

CAU-28A

. . . FROM OIL STOCKS, BUTANES AND PROPANES— THE POLYFORM AND GAS REVERSION PROCESSES

Under the patents of the Gulf Oil Corporation and Phillips Petroleum Company, Lummus designs, builds and licenses Polyform and Gas Reversion units which produce:

— aviation gasoline base stock.
— toluol.
— high overall yields of motor gasoline with high octane, good distillation characteristics, color, gum, oxidation stability, blending value and lead susceptibility.
— research octane of from 85 to 95.
— a spread between the CFR-ASTM and research octane of from 9 to 14 numbers— and between CFR-ASTM and road octane of 3 to 8 numbers.

Write for complete data on Polyform and Gas Reversion processes.

THE LUMMUS COMPANY, 420 Lexington Avenue, NEW YORK, N. Y.
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LUMMUS

PETROLEUM REFINING PLANTS

packages of first aid dressings and treatments, may be inserted into the kit without removing it from the wall. Made of drawn aluminum, the kit is 4½ x 11½ inches, and is furnished complete with bandages, compresses, ointments, inhalants, tweezers, scissors and instruction book.

Engine Switch

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

A safety switch designed to interrupt operation of internal combustion engines if the lubricating oil pressure drops hazardously low or if the cooling water temperature rises too high, has been announced by Minneapolis-Honeywell

Minneapolis-Honeywell Engine Cutout

Regulator Company, Minneapolis, Minnesota.

Available in two models, P607A has manual reset button which must be depressed until the motor starts and the oil pressure rises to normal, while P607B is designed for use on motors with automatic starting equipment where a means is provided to shunt the circuit around the switch until the motor starts and the oil pressure rises to normal.

For engines with a distributor-type ignition, the device is wired to break circuit on temperature rise or pressure fall; for engines with a magneto type of ignition, the opposite terminals are used which short circuits the primary of the spark coil to the ground, while for Diesel engines, the device is set up to control a solenoid valve installed in the fuel line to the injection system.

It employs a 4 x ¼-inch temperature element capsule that may be inserted in any ½-inch pipe tapping in the block. There is no separable well to install as a special packing gland is furnished. A mercury switch handles the switching action. The unit is 6⅛ inches high, 5-9/16 inches wide and 2-11/16 inches deep.

Pipe Threader

THE OSTER MANUFACTURING COMPANY

A portable pipe machine, designated Model 502 Pipe Master and equipped with a sliding, floating type die-head described as adjustable and quick-opening, has been announced by The Oster Manufacturing Company, 2057 East 61 Place, Cleveland.

The die-head is of front-cutting design to make it possible to handle nipples as short as 3½ inches in the 2-inch size without use of a special nipple chuck. A cone-fluted reamer of new design is mounted on the front of the die-head and integral with it to enable the operator to handle close work efficiently. The cut-off device uses standard cutter wheels and rollers, and is of all-steel construction.

A carriage that floats on all-steel ways is designed to allow the die-head and dies to conform to irregularities in the pipe. The carriage, fed by a hand lever, may be removed to lighten the carrying weight of the machine, if desired.

A three-jaw centering chuck on the rear of the spindle is provided to assist the front gripping chuck in centering the longer lengths of pipe. A thread-length gauge can be set to provide duplicate, standard-length threads. An oil pump geared direct to the motor, with

Oster's Model 502 Pipe Master

adjustable relief valve, supplies cutting oil to the dies. All-steel base is welded for maximum strength and minimum weight.

Power is furnished by a ½-horsepower Black & Decker universal, reversible variable-speed motor that may be operated from an ordinary electric light socket.

Overall length of the machine is 46

FOR LONG STEAM LINES OUT-OF-DOORS

For instance, in refineries where distances are great and the condensate cannot be returned to the boiler, you will find thousands of Sarco No. 87's—the liquid expansion steam trap which is not only nonfreezing but is in itself a fairly accurate temperature control. It is used to drain heating lines on the orifice lines to steam, gas and oil meters; and as an inexpensive form of temperature regulation for storage tanks, tank car heating coils, etc. Ask for Catalog No. 48.

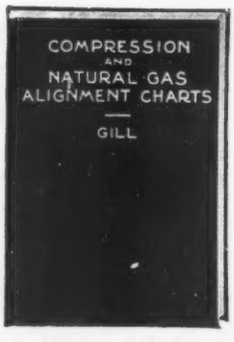
SARCO SAVES STEAM

SARCO COMPANY, INC.
183 Madison Avenue, New York, N. Y.
SARCO CANADA LTD., FEDERAL BLDG., TORONTO, ONT.

85

COMPRESSION AND NATURAL GAS ALIGNMENT CHARTS

By THOMAS T. GILL



The charts in this book have been found useful in solving field problems arising in connection with the measurement, compression and transmission of natural gas, and in the manufacture of natural or casinghead gas. As many of the formulas in common use in natural gas operations are of an impirical nature, with constants that must be evaluated under varying conditions, it will be found that alignment charts are sufficiently accurate for nearly all purposes except for metering large quantities of gas, and here they serve as an excellent check on other calculations. Contains 41 charts, 65 problems. Price $3.50 Postpaid.

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P. O. Box 2608
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VINSON SUPPLY COMPANY

DOUBLES WAREHOUSE STOCKS OF

★ FISHER AUTOMATIC CONTROLLERS

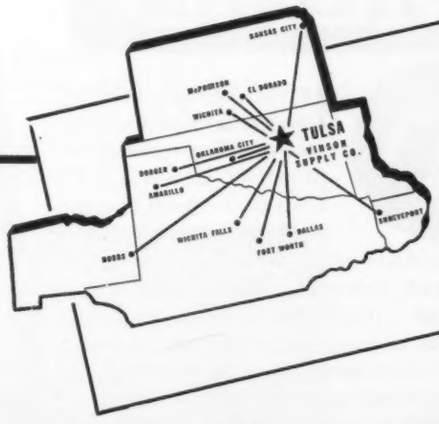
★ TUBE-TURNS

★ NATIONAL TUBE

★ CHASE CONDENSER TUBES

Proposed armament programs indicate the possibility of slower deliveries from manufacturers. To protect our customers against costly delays VINSON SUPPLY COMPANY has actually doubled its warehouse stock of these refinery equipment lines: 1. Fisher Controls and Regulators, 2. National Steel Condenser Tubes—standard, extra strong and large OD seamless pipe, 3. Tube-Turns line of welding fittings and flanges, 4. Chase Brass Condenser Tubes. From this greatly enlarged stock we can meet your exact needs now and in the future.

VINSON Sales Engineers are thoroughly trained specialists and VINSON offices and warehouse assure quick service and prompt shipment. Call in a VINSON man for information and prices on all the equipment lines we distribute.



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Main Offices and Warehouse:
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220 North Boston, Tel. 2-3296

District Sales Offices:
DALLAS, TEXAS
1602 Tower Petroleum Bldg., Tel. 2-4927

inches, width is 19½ inches, height is 18 inches, and weight is 280 pounds complete, and 215 pounds with carriage removed.

Neoprene Suit

INDUSTRIAL PRODUCTS COMPANY

A neoprene suit, designed for resistance to oils and acids, has been announced by Industrial Products Company, 800 West Somerset Street, Philadelphia.

Of two-piece design with all seams vulcanized, it is available in three sizes. The jacket has square shoulders with low stand-up collar, ball and socket snap fasteners with fly front. Pants are of the bib type, with adjustable suspenders of the same material.

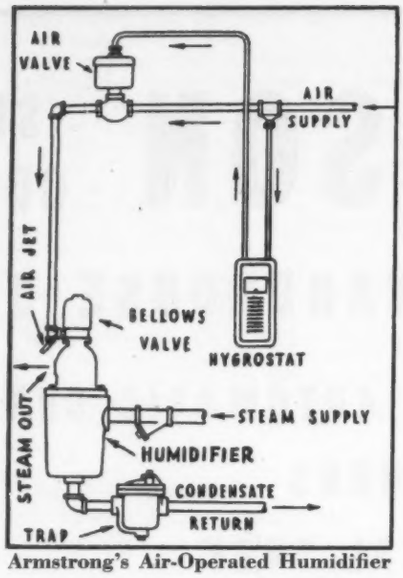
The suits are available on order with harness snaps or zipper instead of ball and socket fasteners.

Humidifier

ARMSTRONG MACHINE WORKS

An air-operated steam-type humidifier for installation in locations where electric circuits would be undesirable has been announced by Armstrong Machine Works, Three Rivers, Michigan.

The assembly includes a pneumatic hygrostat which acts as a pilot valve to admit pressure to the diaphragm chamber of the main air valve when the relative humidity drops below the desired percentage. Opening of the main air valve allows compressed air to flow to the humidifier when the pressure builds up, and opens a steam valve in the top of the humidifier. The steam valve admits steam to a special silencing chamber in the humidifier from whence it escapes directly to the atmosphere to add humidity to the room. A small amount of compressed air blowing through a nozzle directly above the steam outlet is designed to facilitate circulation and distribution of the steam.



Armstrong's Air-Operated Humidifier

The silencing chamber is jacketed with steam at a pressure several pounds above atmosphere to insure dryness of the steam released by the humidifier. A steam trap is designed to prevent accumulation of condensate in the steam jacket.

The unit has a maximum capacity for adding moisture to the air at the rate of 44 pounds per hour, which under average conditions is sufficient for 40,000 cubic feet of space. Compressed air may be any pressure from 20 to 100 pounds, or less.

Floor Covering

TRUSCON LABORATORIES

A rubber-base coating for wood or concrete floors, designed for use on cement floors and described as unaffected by alkali or moisture, has been announced by Truscon Laboratories, Detroit.

Designated Paratex, the product employs a chlorinated rubber base liquid. It is described as flowing easily and brushing out smoothly so that it may be applied readily with a brush. It is available in tile red, stone gray, brown, concrete gray, blue and green.

Proportioner

D. W. HAERING & COMPANY

A feeder for proportioning liquids into liquids or gases, designated Model B and operating on the pressure difference between pitot tubes, has been announced by D. W. Haering & Company, 2308 South Winchester Avenue, Chicago.

The feeder employs flexible steel tubing on pitot tubes and cross lines to take up stress and shock of water hammer or slight misalignments due to curling of welded connections. Check valve is installed on the needle valve line to prevent reagent backing into the needle-valve line and to prevent clogging or corrosion. The arrangement is designed to provide perfect check valve performance and better drop feed indication.

Gauge glasses are installed on the in-

PIPEWRENCH PETE SAYS:

LET THE TIGHT-ROPE WALKERS WORRY

"Used to be a worry wart, I did, on how to get inverted traps to work. Buckets balanced, traps would spit and dribble. Then I discovered Strong Traps with their patented anti-balancing device. Further down the bucket goes, the wider the vent. Let the tight-rope walkers worry about balance from now on. I'm sticking to fast-action, anti-balance Strong Inverted Traps."

Write for Bulletin 63-R5 on Strong Steam Traps

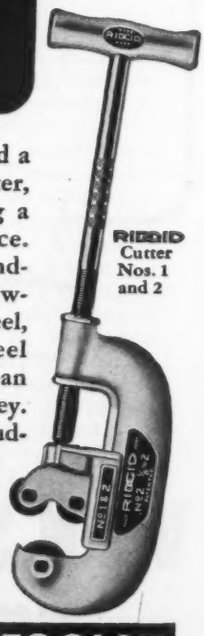
STRONG

STEAM TRAPS

The Strong, Carlisle & Hammond Company
1392 West Third Street, Cleveland, Ohio

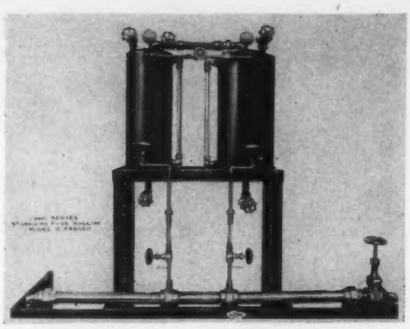
Cut Your Pipe More Quickly, Cleanly, at Lower Cost with a RIDGID

IF you haven't tried a RIDGID Pipe Cutter, you've been missing a pleasant experience. For this modern standard RIDGID has a new-type thin blade cutter wheel of tool steel, forged and assembled in a solid steel bushed hub—to give you many more clean quick cuts, saving you time and money. There are also heavy-duty cutters, including a new trench type four wheel cutter. All are built to hold alignment, always cut true. For economy and better work, ask your Supply House for RIDGIDs.


RIDGID Cutter Nos. 1 and 2

THE RIDGE TOOL CO. • ELYRIA, OHIO

RIDGID PIPE TOOLS



Haering's Model B Proportioner

side of the units, facing each other, to protect them from accidental damage and to reduce hazard from gauge glass breakage. Overall height of fluid compartments has been increased from previous models to provide greater capacity and safety from red oil losses. The needle valve line has been brought out in front of the tanks to reduce friction loss and gas binding, and to increase sensitivity and accuracy.

Arc Welder

GENERAL ELECTRIC COMPANY

A DC arc welder to provide any welding current from 25 to 250 amperes has been announced by General Electric Company, Schenectady, New York. It is designed to allow all-day manual welding with currents up to 200 amperes, using electrodes from 1/16- to 3/16-inch in diameter, and for use of electrodes as large as ¼-inch on occasional short jobs.

The unit provides for instant recovery of the voltage to an extent greater than the arc voltage after each short circuit to prevent time-wasting arc pop-outs, and is designed to never allow current peaks to exceed three times the steady short-circuit current on any adjustment, thus preventing excessive heat and spatter and resulting in a saving of electrodes.

Other features are isothermic overload protection for the motor, self-excitation to eliminate the necessity for an extra generating unit, quick adjustment of welding current, and horizontal mounting.

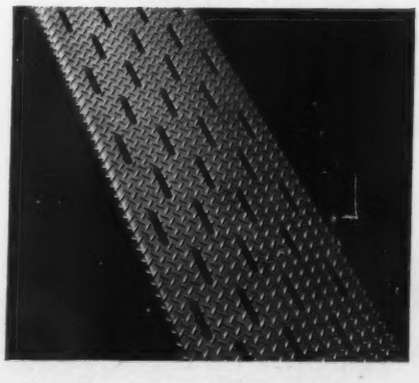
Self-sealed ball bearings are used.

Steel Plate

ALAN WOOD STEEL COMPANY

A slotted-type diamond steel running board, designated Type AW, has been announced by Alan Wood Steel Company, Conshohocken, Pennsylvania.

Made from solid steel plate to minimize possibilities of corrosion and to provide maximum service, design of the product employs slots in a manner that provides protection against falling accidents and facilitates drainage. Slots are hand-hold size for extra security.



Alan Wood Type AW Running Board

Trap

W. H. NICHOLSON & COMPANY

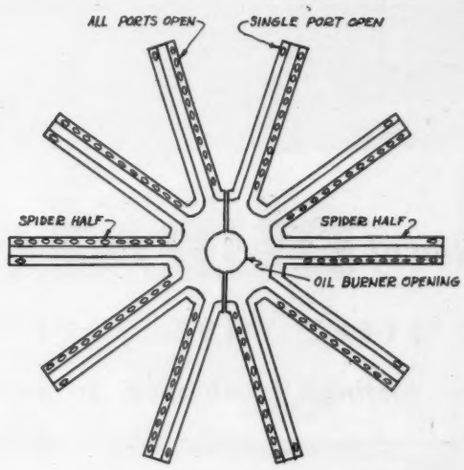
A weight-operated trap for steam, air or gasoline service in pressures 500 to 1500 pounds and maximum temperature of 1000° F., has been announced by W. H. Nicholson & Company, 12 Oregon Street, Wilkes-Barre, Pennsylvania.

It is furnished in one body size with inlet and outlet flanges to suit either Series 60 or Series 150 American standard raised face connections, ½- ¾- or 1-inch size, male and female, or tongue-and-groove flanges are furnished if desired.

Features include cast-steel body and cover; Stellited valve and seat; stainless steel float, latches, brackets and levers; spiral ply stainless steel-asbestos ring gaskets; heat-treated alloy steel stud bolts, threaded full length; intermittent action, and water-sealed discharge valve.

In operation, water entering trap raises float to its highest point of travel, where it releases the weight latch, allowing counterweight to fall. The counterweight is attached to a crank which lifts the discharge valve wide open. The discharge valve is then held open by the link latch until the discharging water carries float to lowest point of its travel. At this point, the weight latch again engages counterweight, which has been lifted by the falling float, and the link

JOHN ZINK adds excitement to his Most Practical Shortest Flame Burner in the World



John Zink BMD Swirling Flame Spider

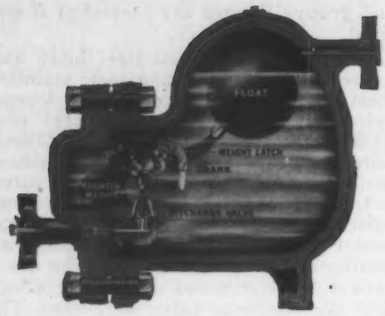
Shortens the flame and gives unbelievable heat distribution. The products of combustion leave the burner in a rapidly spreading bushy swirl. This burner has all the *advantages* and *none* of the disadvantages of a complicated vane register or swirling blades type. No Moving Parts—No Small Ports to Plug.

Write for Information

JOHN ZINK COMPANY

Burners • Floor Furnaces • Unit Heaters

TULSA, OKLA. NEW YORK CITY



Nicholson's Weight-Operated Trap

latch disengages, permitting discharge valve to close. Design precludes wire-drawing of valve and seat by intermittent opening and closing of the valve.

The float is instrumental only in releasing the counterweight, which, as it falls, opens the discharge valve. Opening and closing of the valve does not depend upon the buoyancy of weight of float.

Valves and seats are stocked for 12 pressure ranges, 0 to 500 pounds, to 550, to 600, to 650, to 700, to 800, to 900, to 1000, to 1100, to 1200, to 1350, and to 1500 pounds.

Controller

THE BRISTOL COMPANY

An electronic pyrometer controller without moving parts in the control circuit has been announced by The Bristol Company, Waterbury, Connecticut.

Control is accomplished by means of an electronic circuit using a single high-output vacuum tube of the all-metal type. A milliammeter on the front of the instrument indicates the condition of the control circuit at all times.

Bristol Company's Controller

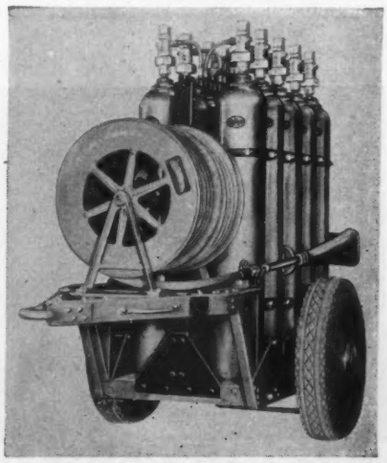
A millivac relay, with entire operating mechanism enclosed in a vacuum is employed to increase sensitivity at the thermocouple. The pointer of the millivoltmeter movement is not engaged or retarded at any point within its normal operating range, the design leaving it free to continuously indicate the temperature under control. The measuring unit is equipped with a cold-end compensator to provide high accuracy.

Fire-Fighting Trailer

C-O-TWO FIRE EQUIPMENT COMPANY

A carbon-dioxide type fire extinguishing unit that can be attached to any truck or tractor and towed to the scene of a fire has been announced by C-O-Two Fire Equipment Company, Newark, New Jersey. It is available in 2- and 4-wheeled models.

The trailers carry as many as 10 50-pound cylinders of carbon dioxide gas, with one or two hose reels with 100-, 150- or 200-foot lengths of high-pressure hose and discharge horns fitted with quick-opening valve for controlling the discharge of gas. The units employ pressure-operated type valves whereby the pressure of the discharging gas from the initially released control cylinders is used to discharge a portion of all of the cylinders simultaneously.



C-O-Two's Fire-Fighting Trailer

Many a ton of **DURALOY**

ALLOY STEEL TUBE SUPPORTS

and other castings is shipped to refineries

. . . . and for several good reasons:

1. **Duraloy Castings are known throughout the industry as sound castings, soundness being the first requisite of an alloy steel casting.**
2. **Duraloy Castings are known to be "right on the nose" on their analyses.**
3. **Duraloy Castings are known to be finished properly.**

Long experience (since 1922) in the casting and finishing of chrome-iron, chrome-nickel, and nickel-chrome castings enables our metallurgists, foundrymen, and machinists to turn out A-1 castings.

Try a DURALOY next time and note its superiority.

We are also pioneers in the production of centrifugal castings—the superior tubular castings with superior metal

THE DURALOY COMPANY

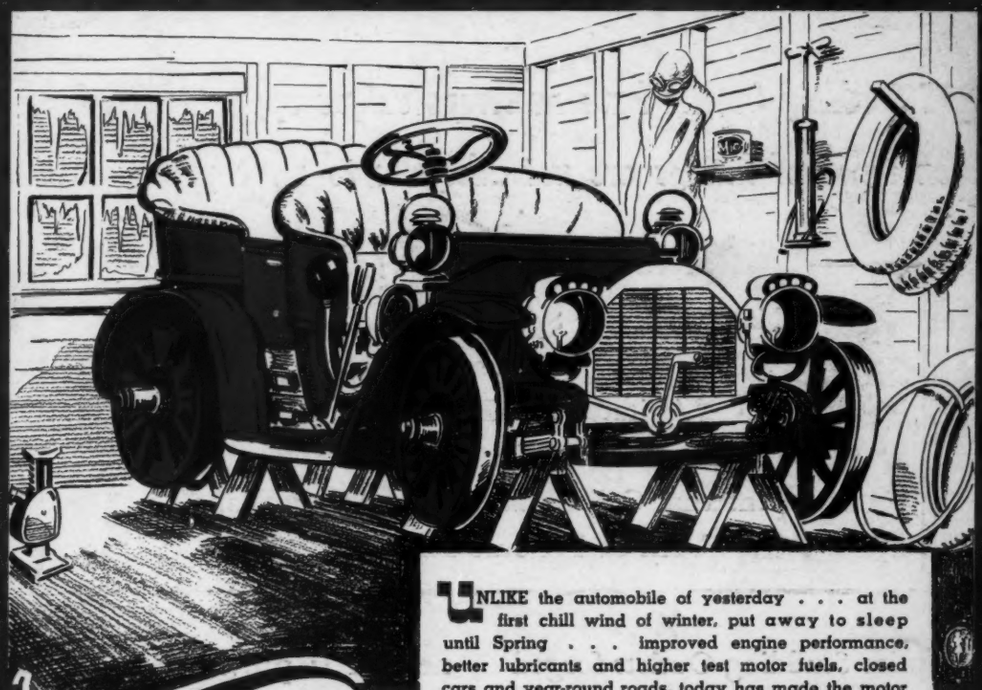
OFFICE AND PLANT: SCOTTDALE, PA.
Eastern Office: 12 East 41st St., New York, N. Y.

Detroit: The Duraloy Co. of Detroit — **Scranton, Pa.: Coffin & Smith**
St. Louis: Metal Goods Corporation — **Los Angeles: Great Western Steel Company**

REFINER
AND NATURAL GASOLINE MANUFACTURER

A Gulf Publishing Company Publication

....and Winter came-1908



UNLIKE the automobile of yesterday . . . at the first chill wind of winter, put away to sleep until Spring . . . improved engine performance, better lubricants and higher test motor fuels, closed cars and year-round roads, today has made the motor car a daily part of our life. With the automobile came Natural Gasoline — an Industry small in the beginning, for the daily capacity of the first Hanlon plant built in 1908, was only a few barrels per day. Today Hanlon-Buchanan supplies domestic, coastwise and foreign markets with thousands of barrels of uniform high quality Stabilized Natural Gasoline.

STA-VOL-ENE
STABILITY ◆ VOLATILITY ◆ ENERGY
IT'S A "NATURAL"

Hanlon-Buchanan, Inc
PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS:
Goodhope, La.
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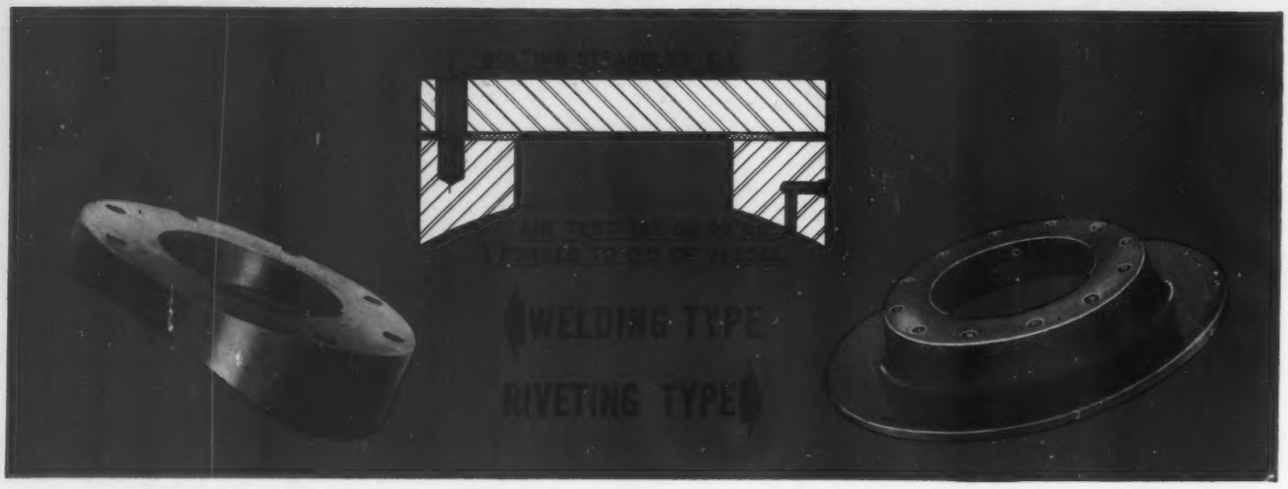
NATIONAL BANK OF TULSA BUILDING
PHONE 4-1101 or L.D. 358 WIRE — OR WRITE P. O. BOX 1539
Cable Address: — STAVOLENE, Tulsa, U. S. A.

FOREIGN REPRESENTATIVE:
Boles, Williams & Co., Ltd.
4 Lloyd's Ave.
London, England

EDITORIAL INDEX, PAGE 3

ADVERTISERS' INDEX, LAST PAGE

For Pressure Vessels LENAPE FORGED STEEL STUDDING OUTLETS



LENAPE Studding Outlets have numerous unique applications where more common types of fittings are not adequate to meet your requirements.

STUDDING OUTLETS IN VESSEL DESIGN

Hand holes or Special Manhole Openings
Sight Glass Fittings
Agitator and Mixer Supports
Liquid Level Controller Mounting
Internal Coil or Thru-pipe Connections
Vent or Pressure Relief Fittings

LENAPE supplies Studding Outlets forged to shell diameter or dished head radius; with any type of facing, blank or tapped as specified; covers to ASA or lighter thicknesses. Air pressure test connection is provided when specified. This product further demonstrates the range and versatility of the Lenape line of accessories for pressure vessels. For more detailed information write:

Lenape HYDRAULIC PRESSING & FORGING CO.
WEST CHESTER, PENNA.

RED MAN PRODUCTS

VINSON SUPPLY COMPANY Tulsa, Oklahoma
JOHN B. ASTELL & COMPANY, INC. New York, N. Y.
HOWARD SUPPLY COMPANY Los Angeles, California
ROBERT F. LANIER & COMPANY Houston, Texas
DIXIE MILL SUPPLY CO. New Orleans, Louisiana

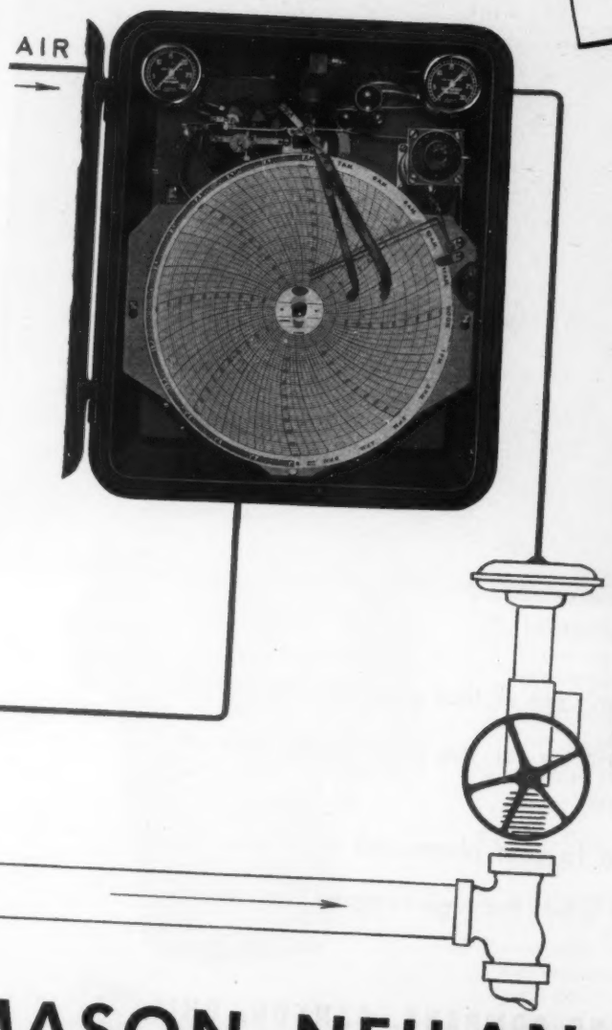
RED MAN PRODUCTS

TO HEADQUARTERS!

SPEED, ACCURACY, SAFETY, ECONOMY

ACCURATE: Permanent calibration is assured by tested construction which eliminates all inherent inaccuracies. Changes in air supply pressure of as much as ± 5 lbs. do not affect accuracy of indication. Unaffected by temperature changes in the air lines. Avoids gas binding and sluggish meter operation.

SENSITIVE: Responsive to 1/10 of 1% change in variable.



FAST: A 100% change in variable transmitted—
200 feet in ½ second; 500 feet in 1 second;
1000 feet in 15 seconds.
These are tested performance figures—not guesswork.

SAFE: Avoids any danger of explosion due to leaking pipes or sparks from switches.

ECONOMICAL: Eliminates all explosion-proof fittings; long lengths of capillary tubing; long runs of meter piping; unsightly, unwieldy back-of-panel piping and manifold connections; expensive high-pressure piping.

ADAPTABLE: Transmitter may be indicator, recorder or controller. Receiver may be recording controller or one-to-four pen recorder. Any combination desired can be supplied. Receiver may be as far as 1500 feet from point of measurement.

SIMPLE, sturdy construction insures long life and reliability.

Before you buy any transmitter system be sure you have all the facts on Masoneilan performance-proved Pneumatic Transmitters. Write for full information today.

MASON-NEILAN REGULATOR CO.

1182 ADAMS STREET, BOSTON, MASS., U. S. A.

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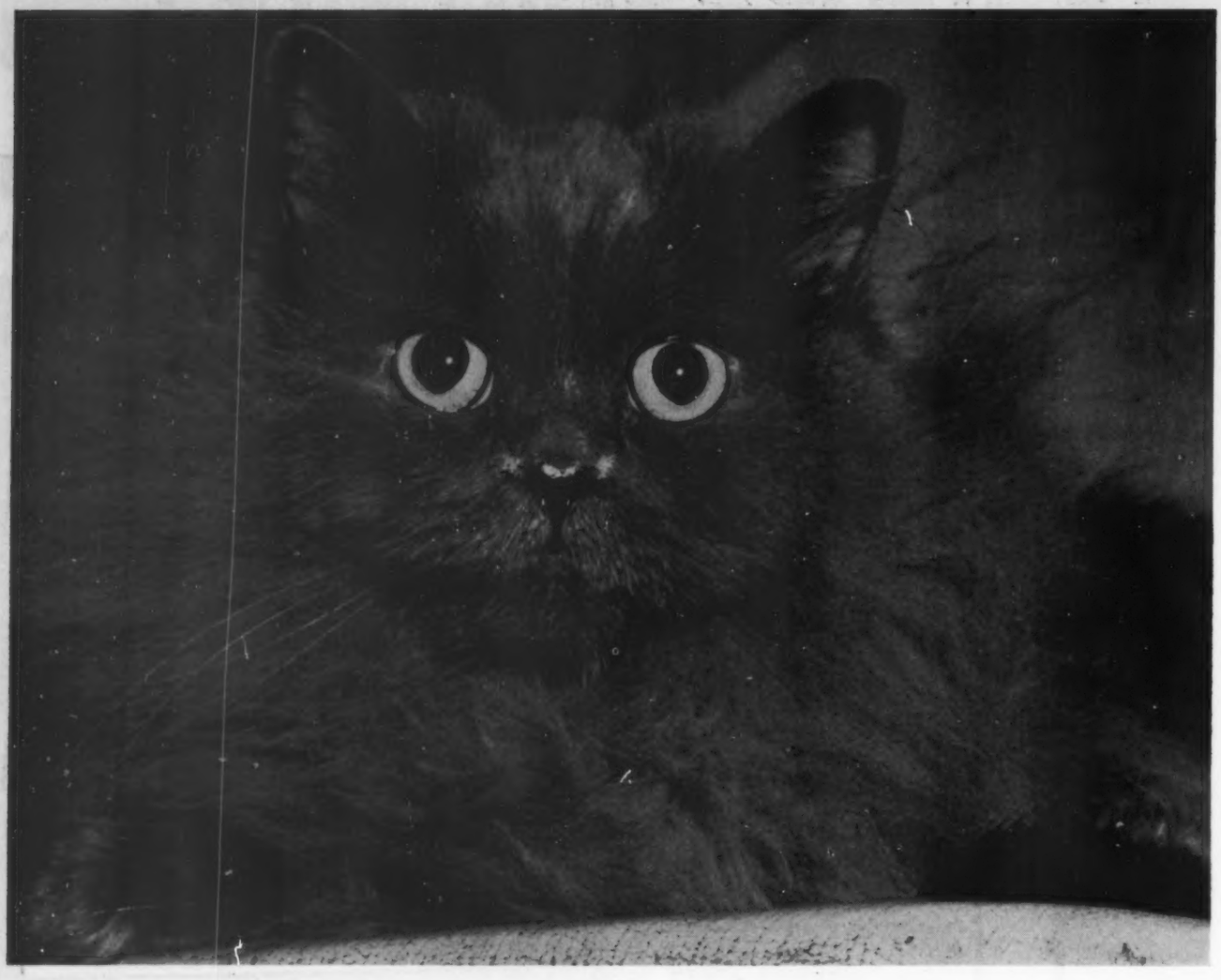
Los Angeles San Francisco Mason Regulator Co., of Canada, Ltd., Montreal, Canada

SEEING *is believing* . . . .



. . . but the most penetrating vision can't see all that goes into your tubes.

A study of performance records will be far more revealing than any manufacturing data we might present.

A Timken representative will respond to your phone call or letter.

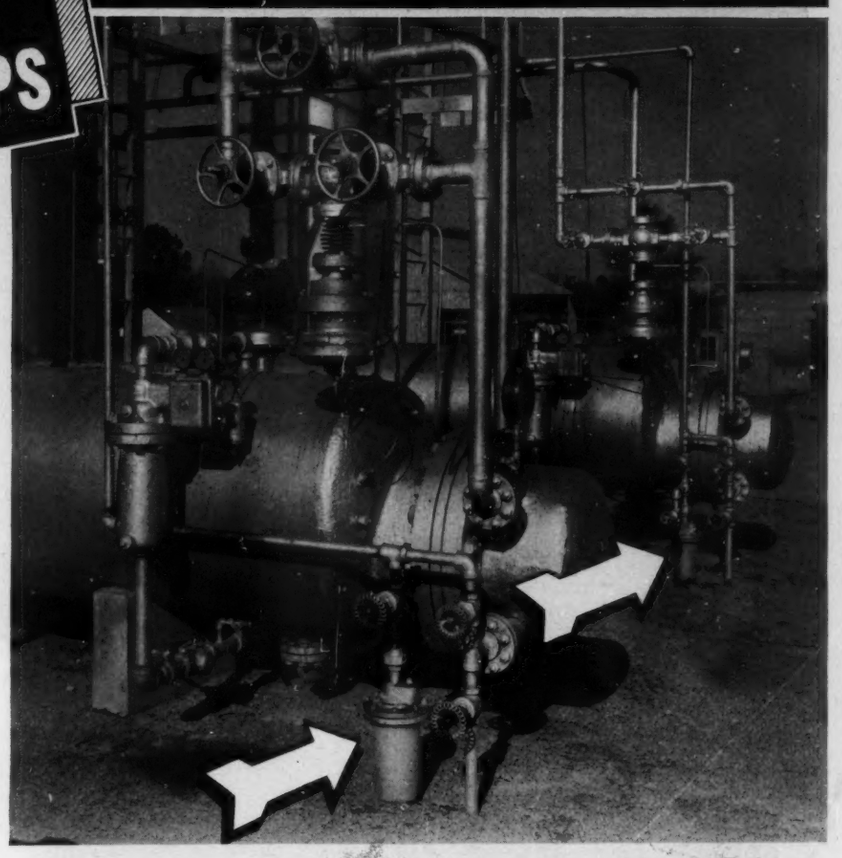
We manufacture a complete line of tubes for high-temperature service. Consult us without obligation.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
Steel and Tube Division

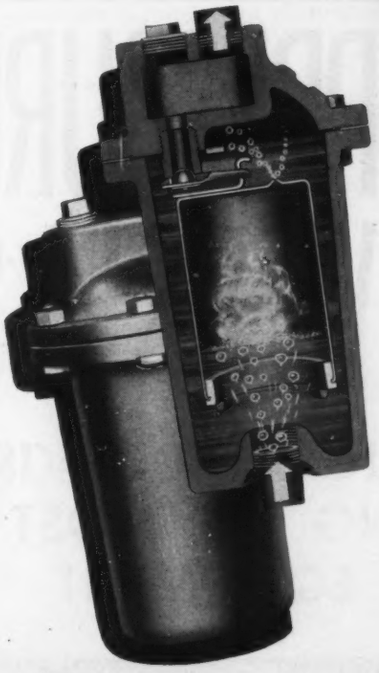
Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; and TIMKEN Rock Bits.

TIMKEN
SEAMLESS STEEL TUBES

ARMSTRONG *Inverted Bucket* STEAM TRAPS *for* Draining Reboilers



The arrows point to two Armstrong Traps on reboilers in natural gasoline plant in Arkansas. Handy engineering data on heat transfer rates is printed in the new Armstrong Steam Trap Book—ASK FOR A COPY.

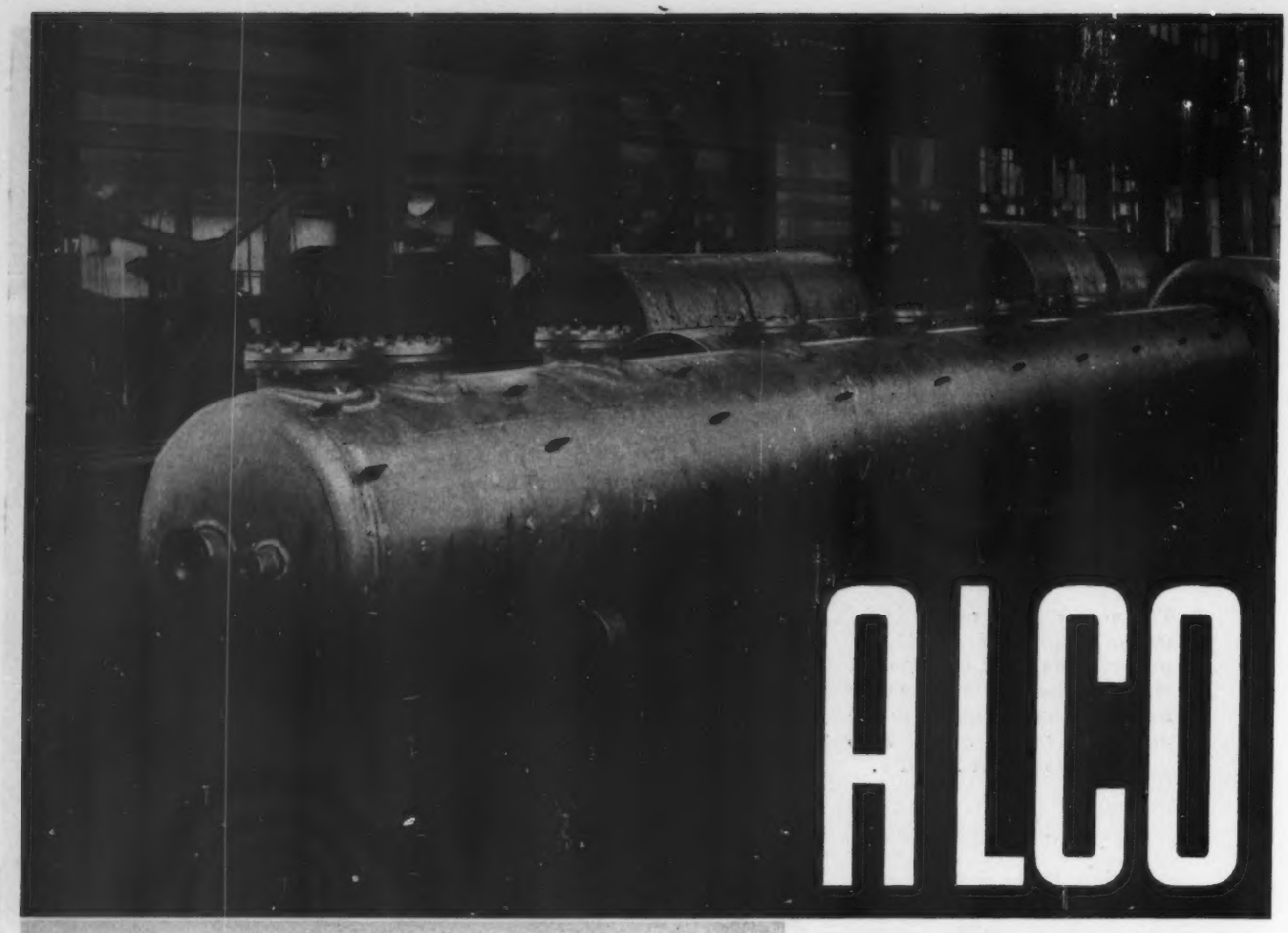


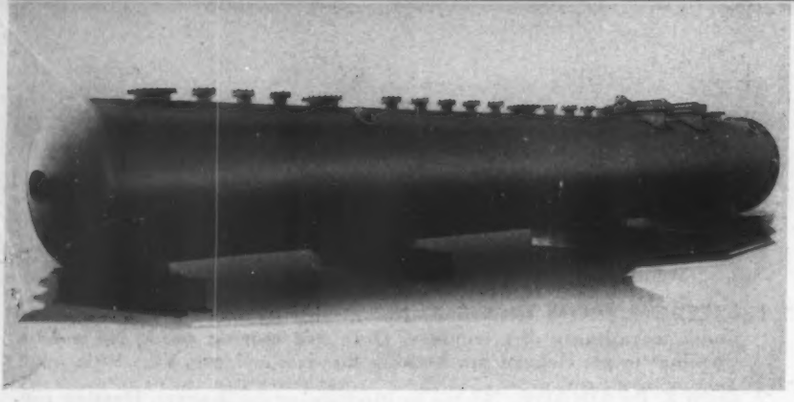
QUICK FACTS:

1. **FREEDOM FROM TROUBLE.** Non-airbinding and self-scrubbing. Immune to ordinary dirt troubles. Only two moving parts. No narrow openings to get clogged up. Nothing that can collapse. Very little wear.
2. **QUICK DRAINAGE.** No lag in discharging condensate. Heating surface is drained continuously, and kept up to maximum efficiency.
3. **COMPLETELY AUTOMATIC.** Nothing to adjust or set. No gage glasses to watch. No petcocks to open. Tight closing—no steam loss.
4. **BIG CAPACITY.** Your dollar buys less dead weight and more real capacity in an Armstrong Trap. Get our capacity chart.
5. **QUALITY CONSTRUCTION.** All-stainless steel interior trim now standard in all sizes. Complete line of traps with forged steel bodies available at moderate cost. All Armstrong traps have valves, seats and mechanisms of same quality and strength as used in traps for 1500 lbs. pressure.
6. **WORLD WIDE SERVICE.** You are never very far from an Armstrong Representative and a stock of Armstrong Traps. ARMSTRONG MACHINE WORKS, 852 Maple Street, Three Rivers, Michigan.

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

ARMSTRONG STEAM TRAPS



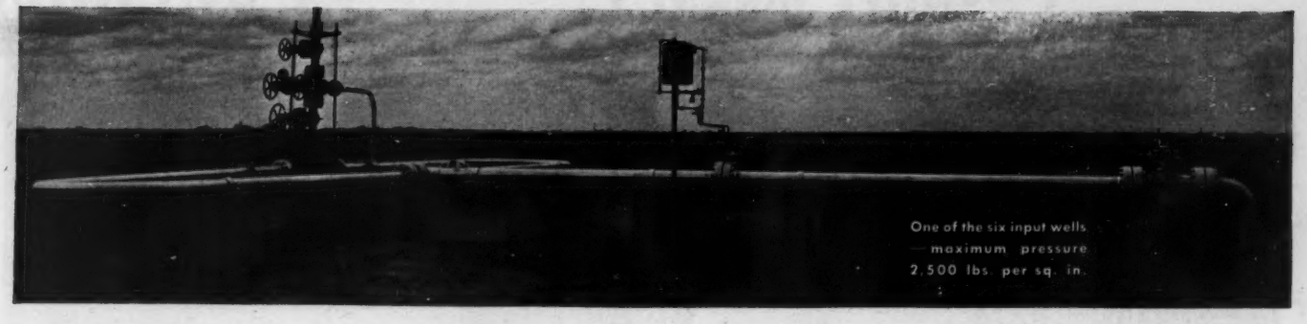


PRESSURE VESSELS

BUILT IN OUR MODERN SHOPS AT DUNKIRK BY EXPERIENCED MEN USING THE MOST MODERN METHODS AND EQUIPMENT

PRESSURE VESSELS • HEAT EXCHANGERS • PRE-FABRICATED PIPING

AMERICAN LOCOMOTIVE COMPANY
ALCO PRODUCTS DIVISION
30 CHURCH ST., NEW YORK, N. Y. DUNKIRK, N. Y.



One of the six input wells — maximum pressure 2,500 lbs. per sq. in.

A headline-making

Repressuring and Recycling Plant

picks its meters

● Repressuring and cycling operations require efficiency and adaptability from instruments—the high-pressure, big-volume range calling particularly for extreme ruggedness. Maximum-profit standards, to which all the operations are geared, also demand close and sustained mechanical accuracy.

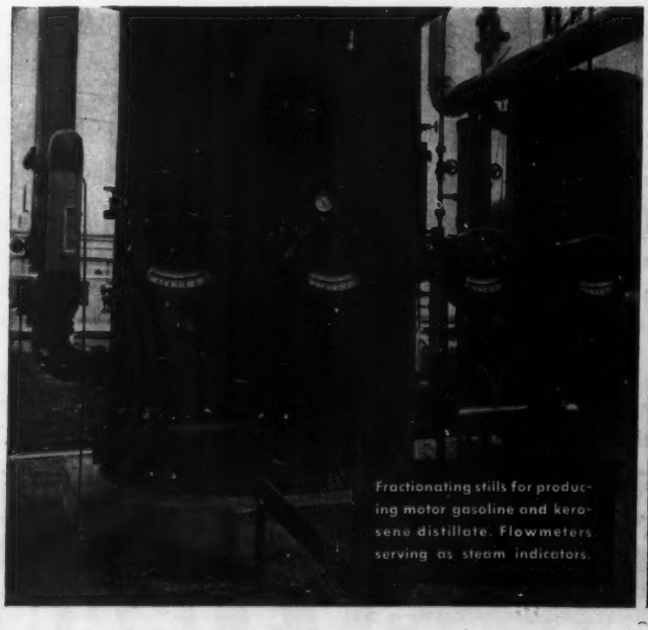
This is true at the Agua Dulce field with its mammoth high-pressure absorption plant for the recovery of gasoline and distillate. Thirty miles of high-pressure gathering lines feed the Coastal Recycling Corporation plant—having a capacity of 140,000,000 cubic feet of gas daily!

Trustworthy **METRIC-AMERICAN** Orifice Meters and Flowmeters are installed at the key input wells, the flowing wells, and—in the distillation circuit—on the fractionating stills and absorbers.

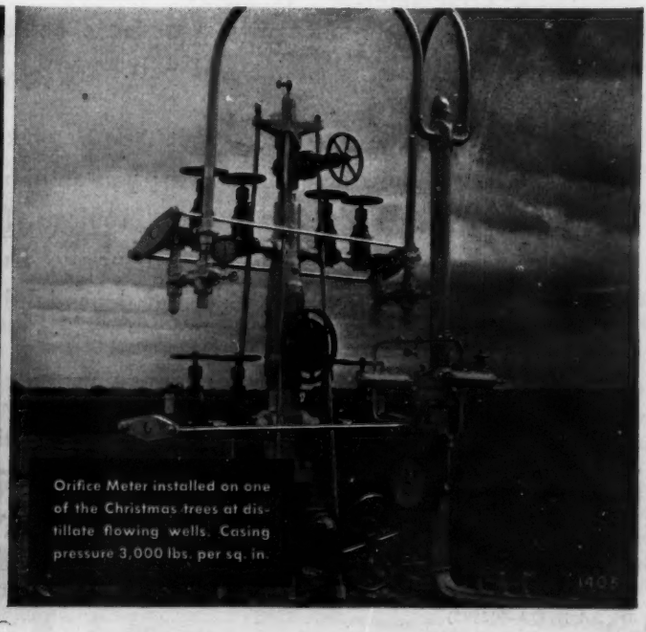
METRIC METAL WORKS • ERIE, PA.

AMERICAN METER COMPANY

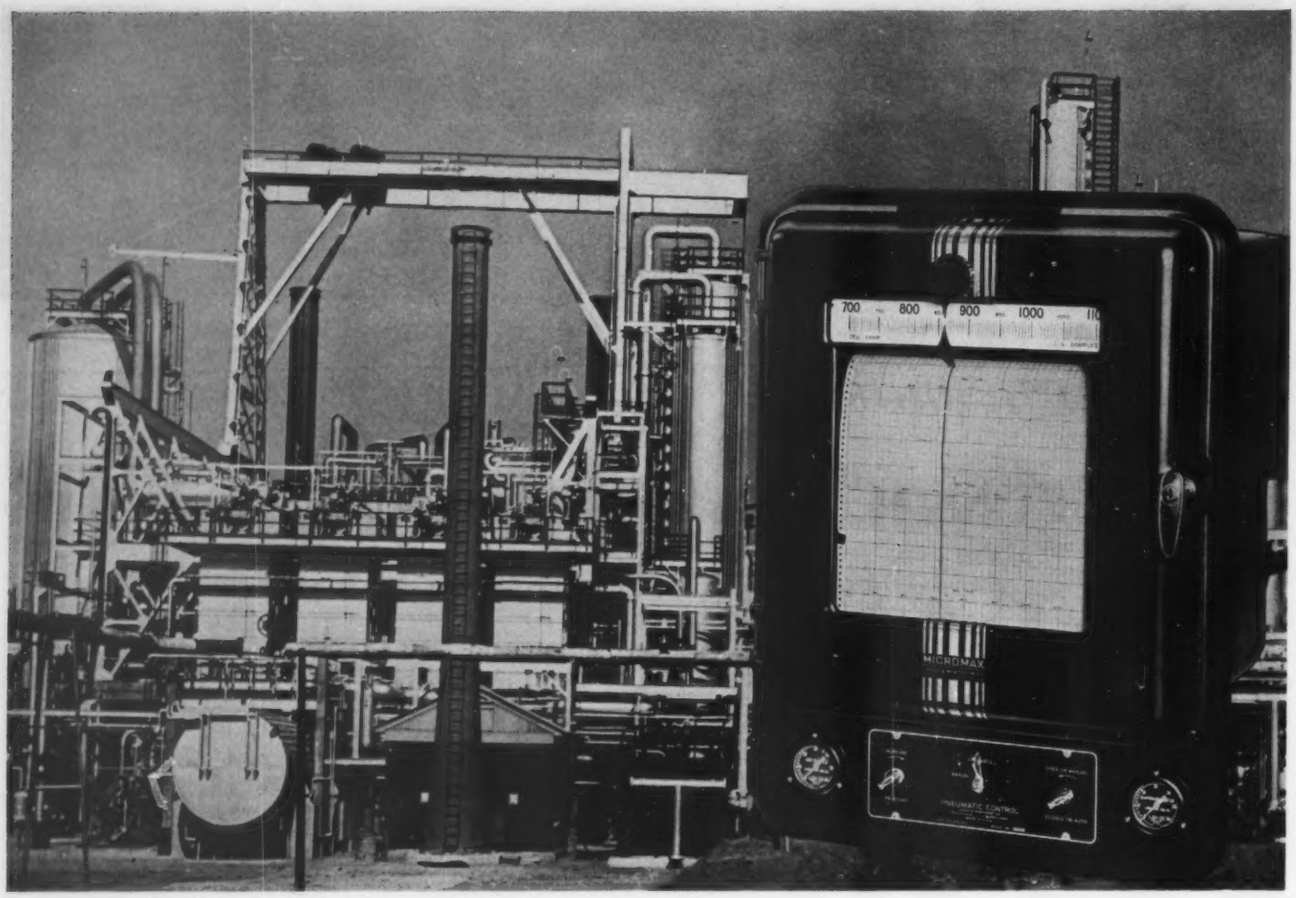
INCORPORATED (ESTABLISHED 1836)



Fractionating stills for producing motor gasoline and kerosene distillate. Flowmeters serving as steam indicators.



Orifice Meter installed on one of the Christmas trees at distillate flowing wells. Casing pressure 3,000 lbs. per sq. in.



THERE'S *Nothing* TO ADD To Your MICROMAX Controller

Every setting that any pyrometric control can use in a refinery, is built into a Micromax Pneumatic Controller as an integral part.

We don't have to know what type or make of valve the Controller is to handle—what type of unit it's to go on—how much load-swing you anticipate—or how much lag. Every Micromax Controller is completely adjustable to any of these problems. Just give us the type of couple, range of calibration and range of pressure in the plant's air-supply. The resulting instrument will help you secure control of unsurpassed sensitivity, accuracy and dependability. For details, see Catalog N-OOB.

LEEDS & NORTHRUP COMPANY, 4923 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33A-702(33)

This COOLING TOWER assures Lower Cost and Higher Efficiency by the very nature of its PATENTS GRANTED and pending!

The MARLEY "DOUBLE-FLOW" *in big Industrial and Utility Plants everywhere is Saving Important Money over all other types of extra-large-capacity cooling towers on Every Item of operation.*

IT MAKES A GREAT DIFFERENCE to the purchaser of a patented article whether the patent claim allowed by the government covers a basic idea and protects a distinctly new and different method—a method which *proves* itself more efficient and economical than other means—or whether the patent granted merely gives one manufacturer exclusive use of a triviality, equally well done other ways.

Marley patents covering *the "Double-Flow" design generally*, and many of *its mechanical and structural features specifically*, are decidedly of the former type. For complete details graphically illustrated—for the interesting *reasons* why "Double-Flow" is so superior for the large-capacity, heavy-duty water cooling task—write for Bulletin 602 now!

Five cardinal advantages have resulted in "Double-Flow" displacing the forced draft tower as the most nearly ideal equipment for large-capacity, heavy-duty water cooling. These advantages are inherent in the "Double-Flow" design, an exclusive patented Marley development. Nothing even similar in operation, economy or performance is available elsewhere.

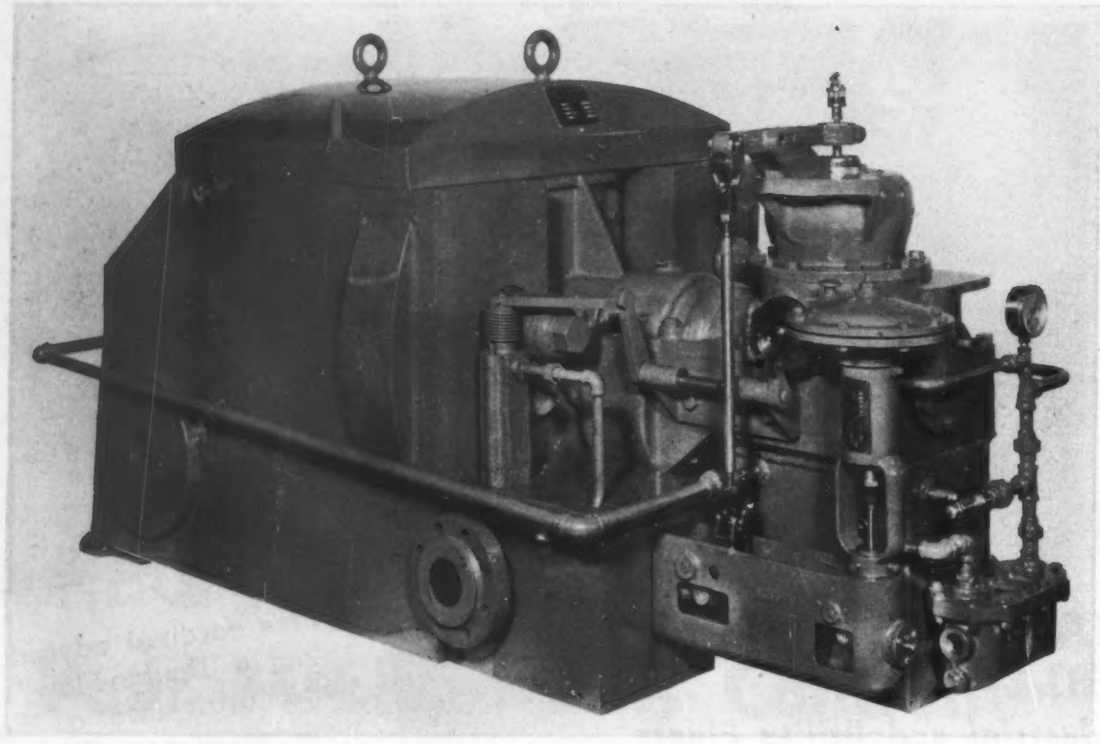
1. **LOWEST PUMPING HEAD**—Extremely low height—Saves on less lift, big pipes, no spray pressure needed.
2. **NO "RECIRCULATION" OF HOT, SATURATED DISCHARGE AIR**—The evil which robs big, low forced-draft towers of from 8% to 20% efficiency just doesn't happen in "Double-Flow."
3. **EXTREME COOLING EFFICIENCY**—In addition to preventing "recirculation," top efficiency is achieved by best mixing of moving air and water ever yet accomplished.
4. **EXTERNAL WATER DISTRIBUTION SYSTEM**—All in easy sight and reach—Cuts maintenance.
5. **NO FAN ICING TROUBLES IN WINTER**—No costly shut-downs and repairs because ice can't form in hot outgoing air stream.

The MARLEY Company

Fairfax and Marley Roads
Kansas City, Kansas

Murray Type "UV"
MULTI-STAGE TURBINES

For Dependable Pump Drive Service



For pump drives demanding the maximum in dependability and economy use Murray Type "UV" Multi-stage Steam Turbines. A wide range of sizes and special features is available to exactly meet your requirements.

The above photograph shows one of three Murray Type "UV" Turbines recently installed in a large industrial power plant for boiler feed service. Each of these turbines is rated at 822 HP at 3600 RPM. Throttle steam conditions are 550 pounds-750° T. T., and back pressure is 16 pounds.

It will pay you to communicate with our district representative or home office concerning your steam turbine requirements.

MURRAY IRON WORKS COMPANY
Burlington, Iowa

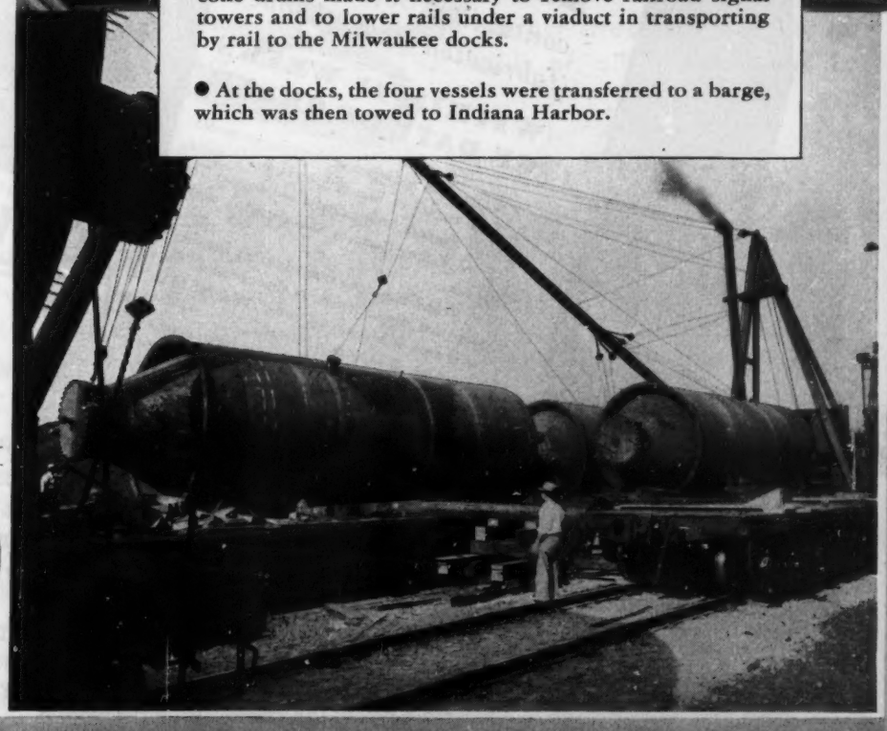
Especially Designed for Their Job...
as Are All SMITH Pressure Vessels

SHOWN at the right are two of the four coke drums recently built by A. O. Smith for a major refiner and transported via rail and water from Milwaukee to Indiana Harbor.

It was natural that the executives and engineers turned to A. O. Smith for these vessels. Smith regards the design and construction of each pressure vessel as a problem requiring *individual* solution and has acquired an enviable reputation for solving such problems successfully.

Unequaled are Smith facilities for the construction of pressure vessels in any size and shape that can be transported either complete or in sections. Bimetallic construction—Smithlining—pioneered by A. O. Smith, is used wherever corrosion problems exist. Smith Pressure Vessels meet all code requirements.

A. O. Smith Corporation, Milwaukee, Wisconsin. Offices at New York, Pittsburgh, Chicago, Tulsa, Dallas, Shreveport, Houston, Corpus Christi, Los Angeles.



- The diameter (16') of four recently completed Smith-made coke drums made it necessary to remove railroad signal towers and to lower rails under a viaduct in transporting by rail to the Milwaukee docks.
- At the docks, the four vessels were transferred to a barge, which was then towed to Indiana Harbor.

DID YOU KNOW?

- A. O. Smith has a *daily* capacity of 12,000 steel frames for autos, trucks, and busses. That number of vehicles is a potential annual consumer of approximately 5,000,000 gals. of gasoline and 100,000 gals. of oil.
- Smith Multi-Layer vessels are *supplanting other constructions* for high-pressure services. They alone can be produced quickly enough in the present emergency.
- Smithlining was specially developed for vessels in corrosive oil refinery service. This method of protection has the *longest satisfactory record* of performance.
- Smith Casing is a typical *Smithway product* in that modern production methods are utilized to obtain higher strength and greater safety at lower cost to the user.

A.O.SMITH
CORPORATION
Milwaukee, Wisconsin

PIONEER MANUFACTURERS OF ELECTRIC-WELDED

Pressure Vessels

Casing · Line Pipe

OK AS CORRECTED!

From REFINER & NATURAL GASOLINE MANUFACTURER, March, 1935.

47 KELLOGG HEAT EXCHANGERS

76

84,525

16

containing 58,000 sq. ft. of heating surface were fabricated and shipped

WITHIN 11 WEEKS OF DATE OF ORDER

Recently a well known refinery organization needed a large number of heat exchangers and required speedy shipment. After careful investigation The M. W. Kellogg Company was selected to supply the units.

The 47 heat exchangers were fabricated, assembled, tested and shipped within the time specified. The units were built according to the A.P.I.-A.S.M.E. code with all welds radiographed.

Such a record could be made only by an organization experienced in designing and building heat transfer equipment, and having shop facilities capable of speedily turning out large quantities of fabricated materials.

KELLOGG

THE M. W. KELLOGG COMPANY · 225 BROADWAY, NEW YORK

MEMO TO ADV. DEPT.

Another record of speedy fabrication of large quantities of heat exchangers has just been established by our shops.....

Incidentally, these heat exchangers were in the field far ahead of construction schedule. This fact should interest a lot of refiners.

KELLOGG

THE M. W. KELLOGG COMPANY

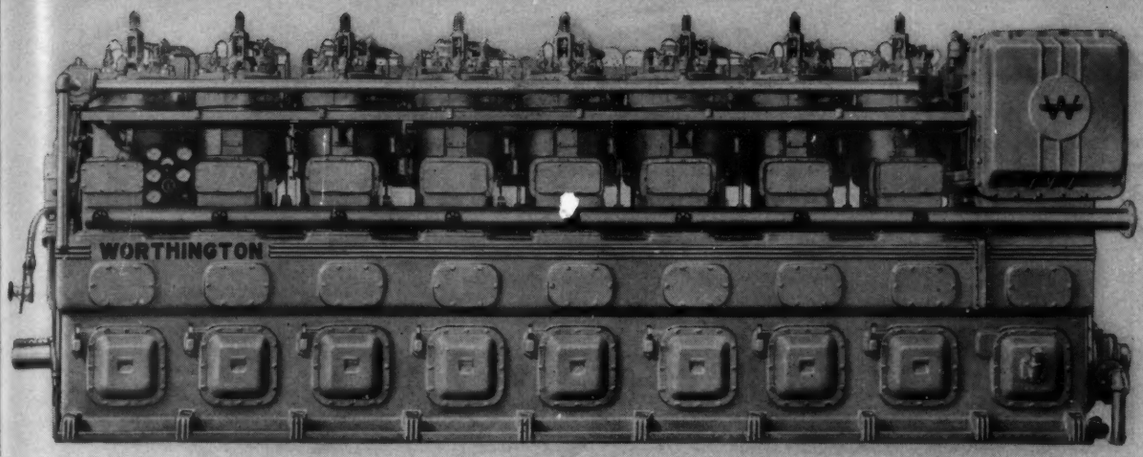
JERSEY CITY, N. J. · 225 BROADWAY, N. Y.

REPRESENTATIVES

LOS ANGELES: 609 SOUTH GRAND TULSA: PHILTOWER BLDG.

"Masterflex"-Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization, Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

HEAVY CONSTRUCTION THROUGHOUT...



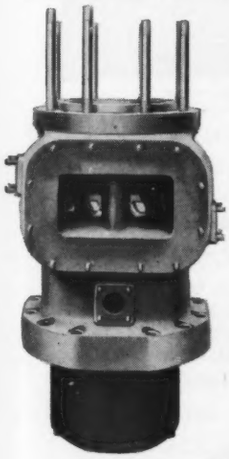
A 1000 hp.
LTC unit

a basic design feature of

WORTHINGTON LTC
ANGLE ENGINE-COMPRESSORS

IN engines built for mobile equipment, or where frequent changes of location are contemplated, light weight construction is essential. However, for stationary engines, designed for long life and continuous full load service, light weight is not desirable.

HEAVY CONSTRUCTION implies the placing of ample masses of metal *in correct structural relation,* to assure *strength, rigidity, maintained alignment, low wear, long life.* The result of all these factors is LOW-COST, TROUBLE-FREE OPERATION.



Cylinder

Cylinder Liner

THE FRAME, the "backbone" of the engine, is carefully designed. Thick walls and flanges, heavy ribbing, box sections, long bearing seats, large studs, deep oil sump —all contribute to strong, rigid construction.

THE CYLINDERS, with replaceable liners, are massive, individual castings—flanges are deep, studs are numerous and large.

THE CYLINDER LINERS are of alloy nickel iron, removable for jacket cleaning, and permitting low cost replacement. They bear on the cylinders at four points, and are double sealed against jacket leakage.

THE MAIN BEARINGS, with steel shells, are held rigidly in place by heavy cast caps and four studs as shown in the picture at the right, assuring permanent alignment and minimum shaft deflection.

THE SHAFT is of large diameter with heavy crank webs.

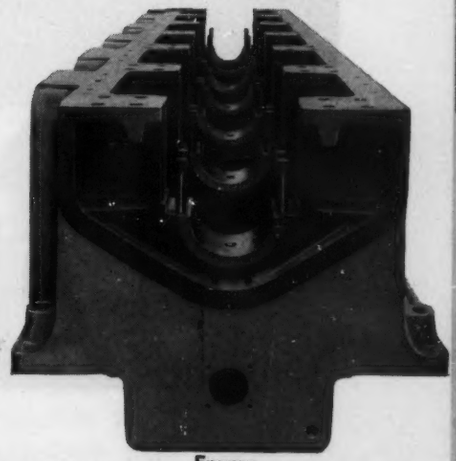
●

SIX SIZES

375 . . . 500 . . . 625 . . . 750 . . . 875 . . . 1000

BRAKE HORSE POWER

COMPRESSOR CYLINDERS—A wide selection of types and designs are available, in cast iron, cast steel or in steel forging as pressures may require. These follow the usual Worthington design as used on motor and steam driven compressors.



Frame

WORTHINGTON LTC
ANGLE ENGINE-COMPRESSORS
HAVE ALL THESE FEATURES

●

HEAVY CONSTRUCTION
STRAIGHT LINE DESIGN
SINGLE SCAVENGING AIR PUMP
REPLACEABLE CYLINDER LINERS
CONE TYPE CYLINDER HEADS
CAST-IN LUBE OIL DUCTS

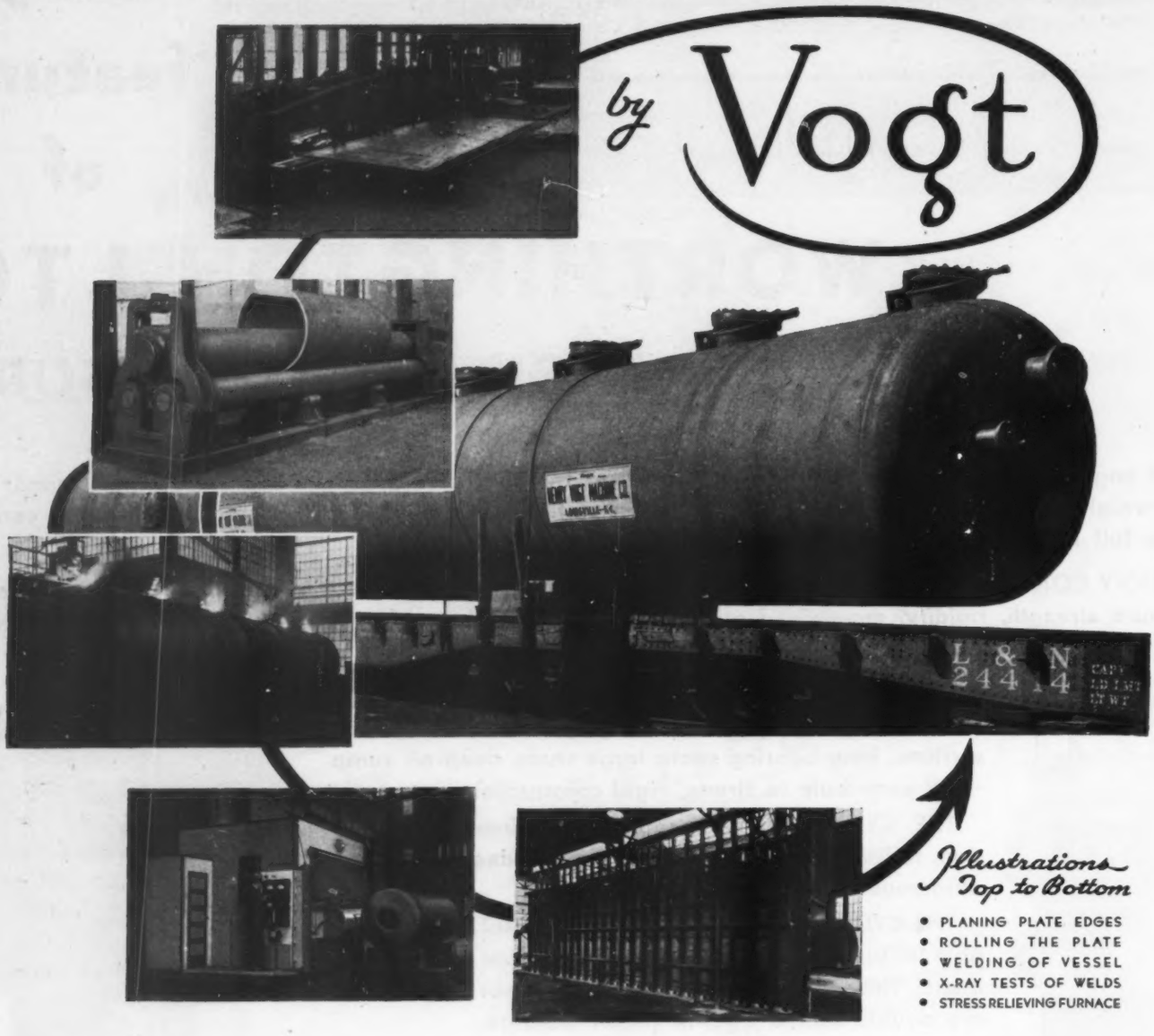
SCO-8

WORTHINGTON PUMP AND MACHINERY CORPORATION • *General Offices:* HARRISON, NEW JERSEY

WORTHINGTON

Fusion welded
PRESSURE VESSEL FABRICATION

by Vogt



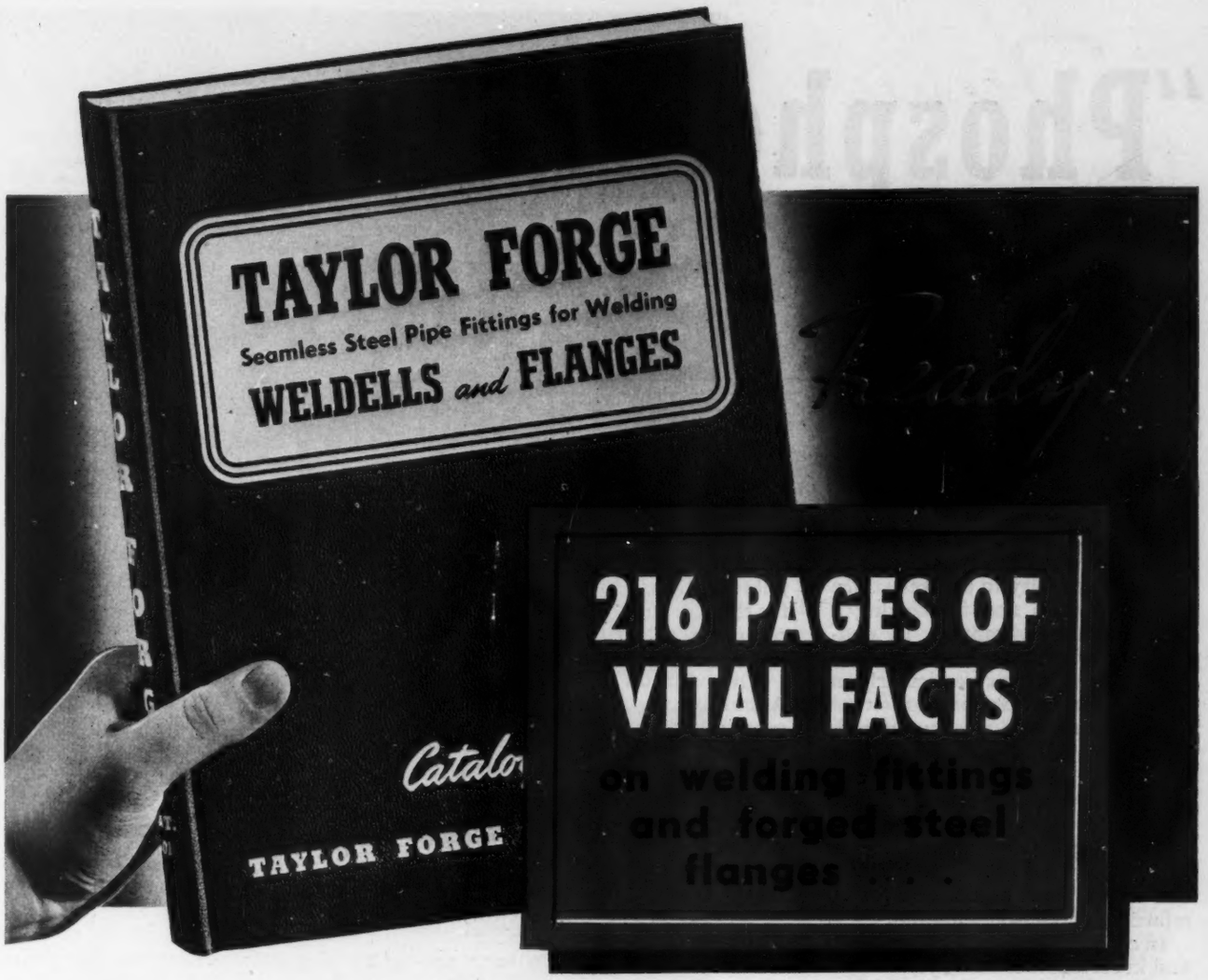
Illustrations Top to Bottom

- PLANING PLATE EDGES
- ROLLING THE PLATE
- WELDING OF VESSEL
- X-RAY TESTS OF WELDS
- STRESS RELIEVING FURNACE

Select the fabricator of your fusion welded vessels with care. To be SAFE you must be SURE! • The Henry Vogt Machine Co. is adequately prepared to meet your present and future needs with a competent welding personnel together with exceptional facilities for fabrication and testing, PLUS an experience accumulated thru many years of successful manufacture. • It is to your own interest to have Vogt quote on welded vessel requirements.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • KANSAS CITY • DALLAS



HERE in a permanent, cloth-bound volume you have the most exhaustive and useable treatise ever published on the application of welding fittings and forged steel flanges.

Beyond the particularly complete and clear dimensional and price data covering Taylor Forge WeldELLS and Forged Steel flanges, its 216 pages contain engineering data that will prove invaluable to the man who purchases, designs or specifies piping, fittings and flanges in carbon and alloy steels.

Among the subjects presented are case studies of flexibility in welded piping, comparisons of theoretical with test results, flange bolting data, complete data on standards, pressure and temperature ratings, sub-normal impact testing data—in fact, far more information on welding fitting and flange application than was ever before published in one volume.

This book is available without charge to interested engineers and organizations. Mail the coupon for your copy.

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Send without cost or obligation, copy of your new 216 page Taylor Forge catalog and data book.

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"Phosphorized Admiralty"

In June of 1939 Scovill published its first report on "Phosphorized Admiralty" tubes. Now less than a year and a half later some 2,500,000 pounds of this material are in service. It has proved far superior to regular Admiralty in severe service in oil refineries and is showing a corresponding advantage in condenser service in power plants and marine installations, particularly in locations where dezincification of regular Admiralty is encountered.

It is generally recognized that Admiralty metal has excellent corrosion-resistant properties, with the result that tubes of this alloy have been given a wide application in condensers for steam power plants and also in heat exchangers for oil refineries and gasoline plants.

In certain conditions of operation and in certain localities(well-known to users of this product), Admiralty metal exhibits a tendency to dezincification on the water side of the tube. Until this time, the most common approach to a solution of this problem has been the use of red brass, and in frequent cases excellent results have been obtained. In certain cases, however, it has been our experience that the use of red brass is not totally satisfactory. Among these are applications with brackish or salt circulating water. Red brass also frequently fails when subject to vapor or petroleum liquid side corrosion with sour or acid streams.

Phosphorized Admiralty metal was developed primarily to improve the resistance of Admiralty metal to dezincification. Only a very small fraction of a percent of Phosphorous is necessary in the alloy for this purpose; thus, the chemical composition of Admiralty metal is not materially changed.

The addition of Phosphorous to Admiralty metal does retard grain growth and in this way results in a finished tube of fine, uniform grain size somewhat superior in physical properties to regular Admiralty metal.

The excellent corrosion-resistant properties of regular Admiralty metal, already proved through years of service, are not impaired by the Phosphorous addition.

Accelerated corrosion tests carried out in the laboratory, both at room temperature and at elevated temperatures, over a long period, showed definitely the superior resistance to dezincification of Phosphorized Admiralty metal over regular Admiralty metal. Curves of these test results for periods of from 60 to 80 weeks are shown here, and require no explanation beyond the bare statement that specimens of these metals are totally immersed in 1% cupric chloride solution, and at stated periods are removed and tests performed on the specimens to determine the residual tensile strength and elongation. This has been found to be a more accurate measure of the rate of corrosion than loss of weight or visual inspection or measurement of reduced dimensions.

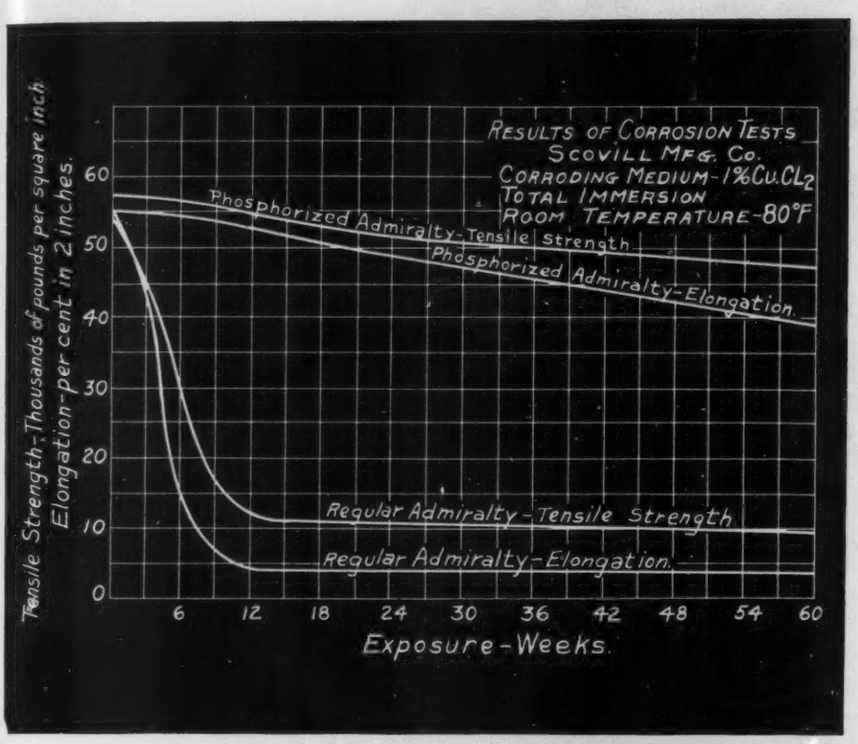
A large number of installations of Phosphorized Admiralty metal tubes are now in service and reports of their ability to withstand both general corrosion and dezincification are very favorable. The conclusions drawn from the laboratory tests of this alloy have been corroborated in actual service.

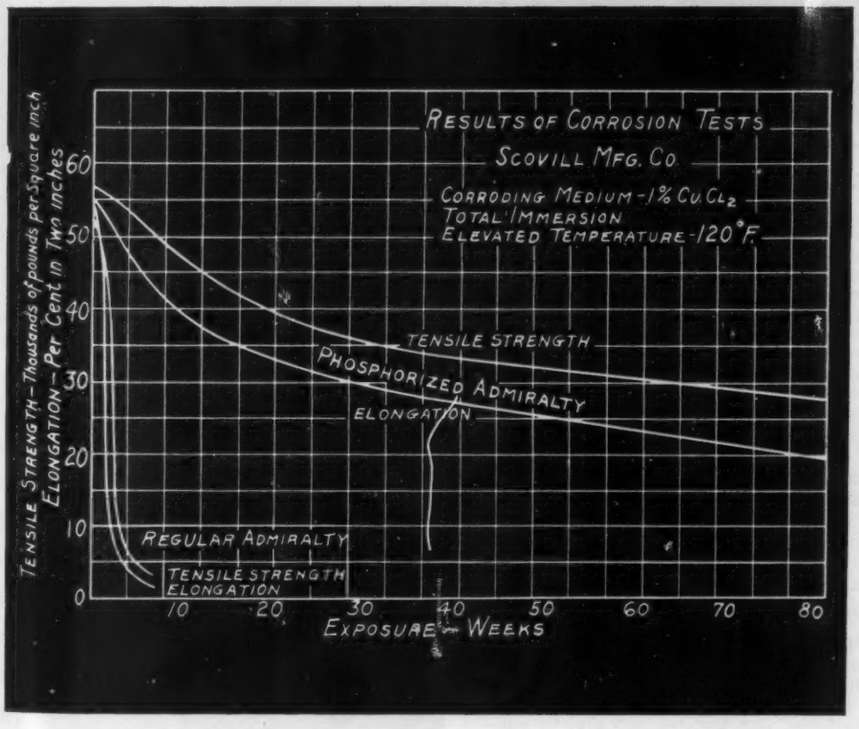
Wherever dezincification of Admiralty metal tubes has been a serious corrosion problem, the use of Phosphorized Admiralty metal tubes is suggested. This alloy combines the general excellent corrosion-resistant properties of Admiralty metal, a desirable fine grain structure of the finished tubes, favorable physical properties and a very definite improvement over Admiralty metal in its very marked resistance to dezincification.

While phosphorized Admiralty was developed primarily for oil refineries and gasoline plants because in those places the phenomenon of dezincification is pronounced and widespread, we see no reason why it should not be equally applicable to any situation where dezincification of Admiralty is a problem — particularly at elevated temperatures.

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL
one product . . .
SERVICE IN MANUALS . . .





SCOVILL'S 3 SERVICES SAVE TIME and MONEY

Service in Manuals

The information in this article is similar to the type of information you will find in Scovill Manuals. The new "Condenser Tube Booklet" is now available without charge to all users of condenser or heat exchanger tubes. Write for your copy to Scovill Manufacturing Company, 15 Mill Street, Waterbury, Conn.

Service in Metals

The research in metals which this article describes is part of Scovill's service in metals; the development of alloys which will give you better performance. Scovill Laboratories also have the responsibility of testing raw materials, testing finished tubes before shipment and analyzing problems of tubes in service.

Service in Men

Engineering representatives are available to our customers in helping them to pick the alloy that will serve best under the particular operating conditions in your plant. They are also at your service whenever trouble arises, helping to determine and remove the causes.

Condenser Tubes

. . . three services

SERVICE IN METALS . . . SERVICE IN MEN

NATIONAL CARBON GRAPHITE KARBATE PRODUCTS

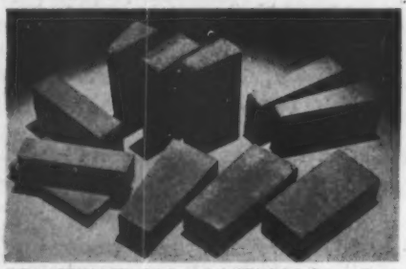
TRADE-MARK TRADE-MARK TRADE-MARK

Reduce Losses

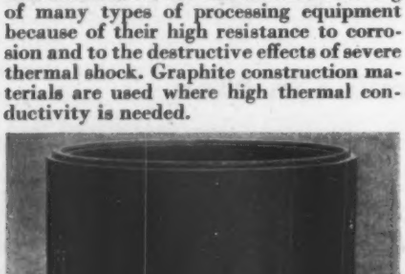
FROM CORROSION, THERMAL SHOCK AND CONTAMINATION OF PRODUCT

● Carbon, Graphite and "Karbate" products are highly resistant to the action of most acids, alkalies and other corrosive materials. They possess good mechanical strength and exceptional resistance to thermal shock.

"Karbate" is a brand of material, of carbon or graphite base, which is impervious to the seepage of fluids under pressure. Graphite and "Karbate" No. 2 have high thermal conductivity and excellent heat transfer properties.

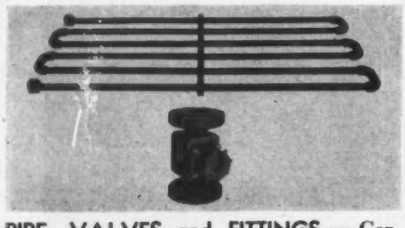


CONSTRUCTION MATERIALS — Carbon and Graphite construction materials are available in a variety of forms including brick, flat tile, blocks, beams, tubes and other structural shapes. These products are used for the construction or lining of many types of processing equipment because of their high resistance to corrosion and to the destructive effects of severe thermal shock. Graphite construction materials are used where high thermal conductivity is needed.

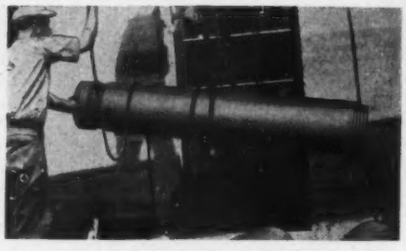


TOWER SECTIONS — Cylindrical carbon tower sections, machined with close fitting tongue and groove joints, can be supplied in sizes up to 33 inches I.D. by 36 inches long. These sections, stacked vertically, provide an economical tower construction for processing corrosive materials.

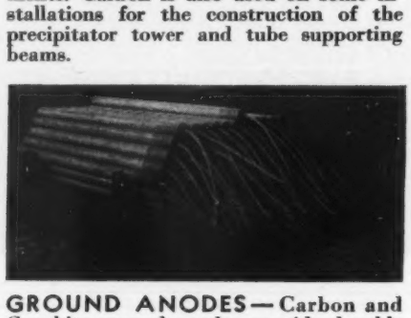
RASCHIG RINGS — Carbon Raschig rings have high resistance to the destructive action of such materials as acids, sulphides and hot alkaline solutions. They provide an ideal tower packing for sweetening gas and petroleum products with caustic soda or other alkalies. Low weight per unit of volume, good mechanical strength and high resistance to thermal shock reduce cost of tower construction and maintenance.



PIPE, VALVES and FITTINGS — Carbon, Graphite and "Karbate" pipe and fittings are available in sizes from ½ inch to 6 inches I.D. Saunders type valves of "Karbate" construction can also be supplied. These corrosion resistant products are used for the construction of heating coils — both steam and gas-flame types, condensers, drain lines and other types of conveying, circulating and heat exchange equipment. Carbon or "Karbate" No. 1 is recommended where high heat transfer properties are not desired. Graphite and "Karbate" No. 2 have heat transfer properties equal to steel pipe of corresponding diameter. Carbon and Graphite pipe and fittings are sufficiently impervious to convey fluids at low pressure without disturbing seepage. At higher pressures, or where all seepage must be prevented, "Karbate" materials are recommended.



ELECTROSTATIC PRECIPITATORS — The use of carbon tubes and supporting collars in electrostatic precipitator construction for the precipitation of corrosive materials eliminates expensive replacements. Carbon is also used on some installations for the construction of the precipitator tower and tube supporting beams.



GROUND ANODES — Carbon and Graphite ground anodes provide durable and economical ground connections for the cathodic protection of metallic structures, tanks and pipe lines against electrolytic corrosion from adverse soil or water conditions. Graphite anodes have proved especially advantageous in the presence of salt water.

Write FOR COMPLETE INFORMATION ON THE PRODUCTS IN WHICH YOU ARE INTERESTED

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
CARBON SALES DIVISION, CLEVELAND, OHIO
General Offices: 30 East 42nd Street, New York, N. Y.

BRANCH SALES OFFICES
•
NEW YORK • PITTSBURGH • CHICAGO
ST. LOUIS • SAN FRANCISCO

To obtain the high efficiencies demanded by current refining methods, greater equipment investments than ever before are being made. The shrewd refiner knows that operation at over-rated capacities, so often necessary, usually results in excessive maintenance costs. Shut-downs due to corrosion, coking, plugging and scaling not only increase costs, but definitely endanger refinery equipment investments because of the excessive depreciation factor. It is obvious, therefore, that *Petreco protection pays.*

The Petreco Electromatic De-Salting Process increases on-stream time by reducing shut-down periods to minimum. Operating difficulties and maintenance problems due to salt corrosion, plugging and scaling have been eliminated in many refineries. In one case, gains attributable directly to the PETRECO PROCESS are estimated at 150% per year on the desalter equipment investment. The Petreco research and engineering facilities are always at your disposal for tests and analyses of your problems. There is no charge or obligation for this service.

PETROLEUM RECTIFYING COMPANY OF CALIFORNIA

General Offices: 530 West Sixth Street, Los Angeles, California

Gulf Coast Division:
1312 Petroleum Bldg., Houston, Texas

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Representatives In Principal Oil Fields and Refining Centers

PETRECO

DE-SALTING DEHYDRATING

TRY TUBE-TURNS with Tube-Turn SLIP-ON FLANGES!

The word "Tube-Turn" is NOT a necessary general trade name for welding fittings. It is the registered trade-mark for the products made by Tube-Turns, Incorporated, under their patents.

● For good piping construction and lowest cost, use Tube-Turns with Tube-Turn Slip-On Flanges whenever flanged joints are required. You'll find that long radius, 1½R Tube-Turns work better with Slip-On Flanges than any other welding elbows because:

First: Tube-Turns, having uniform walls throughout with no excess thickening at the crotch, thus maintain an outside diameter that is extremely close to nominal. *Second:* Tube-Turns are made to such close tolerances that they always slip easily into the bore of slip-on flanges a sufficient depth to meet recommended practice and permit making a sound, strong joint.★

This is just one reason why, for completely dependable piping, it pays always to specify Tube-Turn Fittings and Flanges. The Tube-Turn line includes 90° and 45° Elbows, 180° Returns, Tees, Reducers, Caps, Lap-Joint and Shaped Nipples, Crosses, Laterals, Saddles, and all sizes, weights and types of Forged Steel Flanges. . . . Get all the facts, and a lot of valuable engineering data as well, from our new Catalog and Data Book No. 109. Ask your Tube-Turn Distributor for a copy, or write us direct. TUBE-TURNS, Incorporated, Louisville, Kentucky.

★ In sizes below 4" it is impossible to use slip-on flanges on both ends of *any* stock fittings (Tube-Turns or others) because the flanges project too far to clear each other.

THIS IS

ACTIVATED ALUMINA

USE IT TO: Prevent Valve Freeze-ups...Prevent Internal Corrosion of Lines and Equipment...Produce Dry Gases and Dry Petroleum Products

Activated Alumina is as plain in action as it is in appearance. It *adsorbs* moisture. Gases or organic liquids which flow through a bed of Activated Alumina emerge thoroughly dry. So dry, in fact, that freeze-ups and hydrate formation cannot occur even at the highest working pressures and lowest temperatures, so dry as to prevent corrosion, dry enough to meet the most rigid specifications.

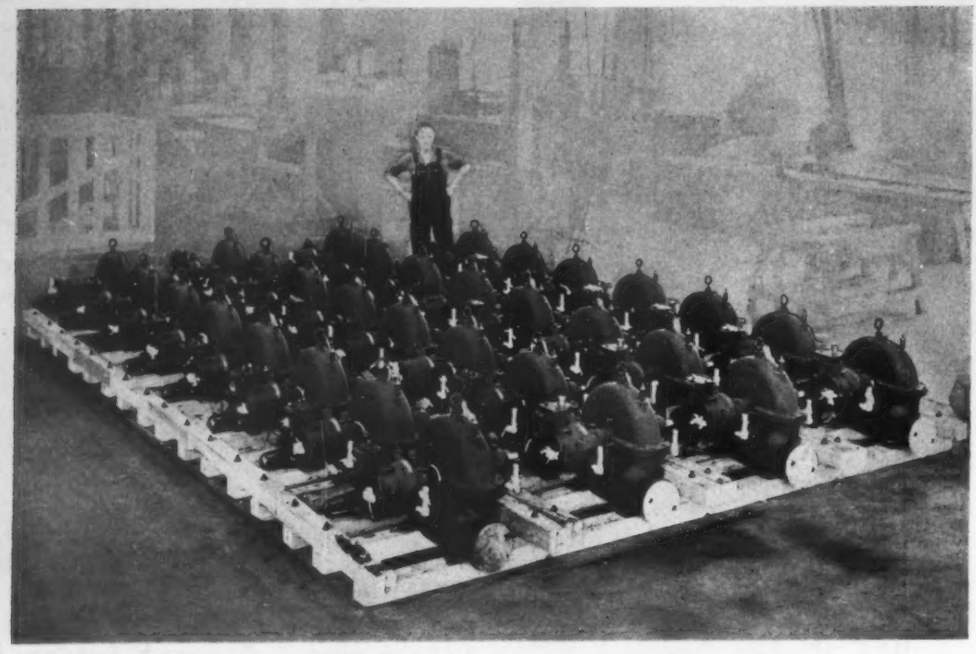
It follows that the apparatus in which Activated Alumina operates is also simple and uncomplicated. No solutions, evaporators, or moving parts are required. This equipment works at line pressure. It requires at most only a few minutes attention each day, and frequently is wholly automatic. The Activated Alumina itself, when properly used, lasts indefinitely without replenishment or replacement.

The cost of using Activated Alumina is low in comparison with the benefits you get from it. Today it is being used in the operation of pipe lines, for the recovery of natural gasoline, and for drying gasoline, propane, and organic liquids. It also has interesting applications as a catalyst and as a catalyst carrier. For information about it, write to ALUMINUM COMPANY OF AMERICA (*Sales Agent for* ALUMINUM ORE COMPANY) 1963 Gulf Building, Pittsburgh, Pennsylvania.

ACTIVATED ALUMINA

AN "ALORCO" ALORCO PRODUCT

TERRY



31 TERRY SOLID WHEEL TURBINES

Recently ordered by a leading oil refiner

These units were selected on the basis of—

. . . Simple and durable construction.

. . . Solid one-piece blade design.

. . . Proven performance—For this Refiner has been a user of Terry Turbines for the past five years and knows their many other inherent qualities.

The Terry Solid Wheel Turbine is described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1139

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Extra-long seamless tubes with no "middle weld" . . .

another advantage of National's *"Complete Tube Service"*

HERE'S another example of the way National's "Complete Tube Service" operates. This service makes available to you not only the widest selection of steel analyses, sizes, and wall thicknesses, but also the longest continuous seamless still tubes—up to 52 feet.

These extra-long tubes solve an important problem in modern refinery operations. They meet the demand for longer tubes due to changes in furnace design and improved methods of refining. As with regular length tubes, they are made to meet all requirements of current specifications. Available in different steels and various wall thicknesses—plus the added advantage of no middle weld.

Why not let one of our refinery tube experts tell you more about National's "Complete Tube Service." It won't cost you a cent, but it may save you thousands of dollars.

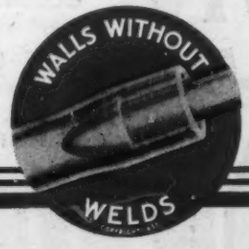
A 300,000-POUND cold-drawing tube bench, the largest in the world, is used in the finishing of NATIONAL Seamless Refinery Tubes.

21 ANALYSES TO CHOOSE FROM

Here is the widest available assortment of steel analyses for still tubes, condenser tubes, heat-exchanger tubes, and refinery piping.

LOW CARBON	3 CR., 1 MOLY.
LOW CARBON, ½ MOLY.	5 CR., ½ MOLY.
1½ SIL., ½ MOLY.	5 CR., ½ MOLY., 1½ SIL.
LOW CARBON, 1 MOLY.	5 CR., ½ MOLY., TITANIUM
1¼ CR., ½ MOLY.	5 CR., ½ MOLY., COLUMBIUM
1¾ CR., ¾ MOLY. (Bain Alloy)	8 CR., 1 MOLY.
2 CR., ½ MOLY.	18-8
2 CR., ½ MOLY., 1¼ SIL.	18-8, TITANIUM
2½ CR., ½ MOLY., ¾ SIL.	18-8, COLUMBIUM
2¼ CR., 1 MOLY.	25 CR., 20 NICKEL
3 CR., ½ MOLY., 1¼ SIL.	

For Still Tubes
Condenser Tubes
Heat Exchanger Tubes
Refinery Piping



NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

16 YEARS OF CONSISTENT LOW COST PRODUCTION

In 1924—16 years ago—Gray Clay Treating Units were first placed in commercial operation.

Since that time Gray Clay Treating acceptance has increased until today it is widely used by all classes of refiners. That's largely because it consistently fits the requirements of refiners for economically treating gasolines in conjunction with a large variety of cracking processes.

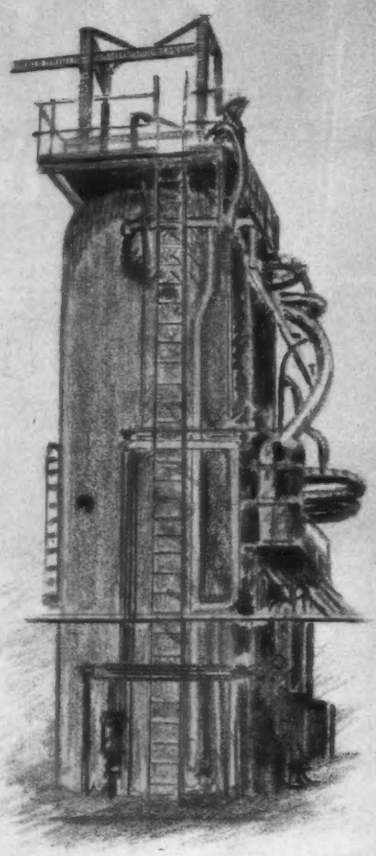
Gray Clay Treating Units will produce low gum content gasoline without loss of octane number. They will last throughout the life of the cracking unit. Often, when new cracking units have replaced old ones, the Gray Process has again been chosen to treat the gasoline.

In these days, the refiner striving for low cost production, will do well to consider the Gray Process. Moderate installation costs, negligible operating labor expense, low cost of adsorbent, minimum maintenance, are all definite economic advantages.

THE GRAY PROCESSES CORPORATION

Licenses granted under United States and Foreign Patents by The Gray Processes Corporation

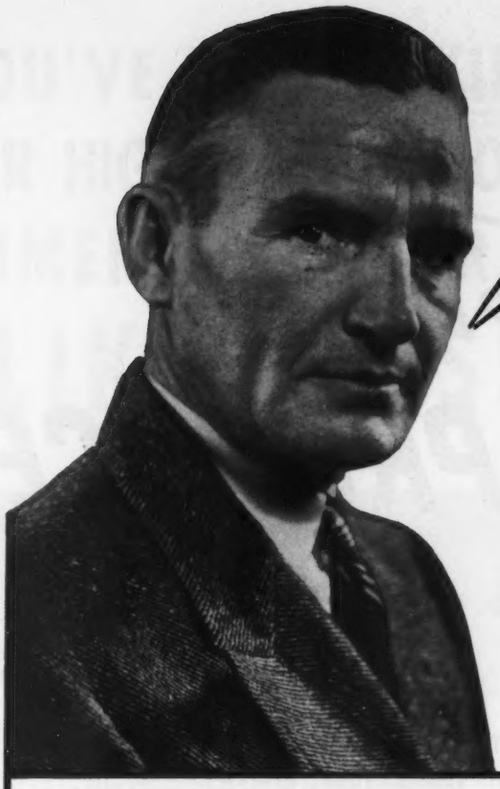
26 JOURNAL SQUARE · JERSEY CITY, NEW JERSEY



OVER 7 MILLION BARRELS

In 1926 a certain refiner installed a small Gray Clay Treating Unit. To date this unit has produced 7,655,000 barrels of low gum content gasoline.

GRAY CLAY TREATING



"NEVER BELIEVED SUCH COMBUSTION RESULTS WERE POSSIBLE"

Says **MAJOR OIL REFINERY, ABOUT THE FANMIX GAS BURNER**

Another COPPUS BLUE RIBBON *Product*

The steam engineer of one of the country's largest petroleum refineries, having operated **FANMIX** burners over a six month period writes: "Since the installation of **FANMIX** Burners the average load on the still has been increased 25%. The flue gas temperature dropped from 620° to 530° F. and the CO_2 increased from 9.4% to 11.4%.

NEW OPERATING METHOD

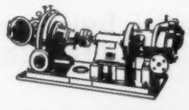
Ensures Perfect Gas . . . Air Ratio

Gas escaping through orifices in the revolving arms, drives the fan and draws in the correct proportion of air. The result is instantaneous, complete combustion. Not only does this give you higher ratings, but you also get eleven other unique benefits from Coppus-Dennis Fanmix Burners.

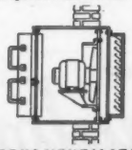
COPPUS BLUE RIBBON PRODUCTS

Designed for your Industry
Engineered for You

COPPUS TANK AND TANK CAR VENTILATORS. For quick ventilation of Tank Cars, Tanks, etc. Supplies fresh cooling air to men working in confined spaces. Bulletin 163-1



COPPUS STEAM TURBINES. For small H.P. jobs—six sizes (and prices) from 150 H.P. down to fractional. Steam — Gas—or Compressed Air driven. Bulletin 135-9



COPPUS VENTILATOR FILTERS. A combination Ventilator and Air Filter for industrial applications. Bulletin F-370-1.

HEAT KILLERS. Keep production up by keeping men cool. Also for cooling of motors, generators, etc Bulletin 160-4.

WRITE FOR FREE FANMIX BULLETIN 410-2

Like all other Coppus products, the Fanmix Gas Burner has a Blue Ribbon. This is your assurance of precision workmanship and careful inspection. Note other Blue Ribbon products described at left. Coppus Engineering Corporation, 360 Park Avenue, Worcester, Massachusetts. Sales offices in THOMAS' REGISTER: other "Blue Ribbon" products in REFINERY CATALOG.

COPPUS

Uncle Sam...

PREPARED TO PRODUCE

WITH TAYLOR'S HELP

FACTORIES hum from coast to coast. Plant lights shine out all through the night. Sounds and sights of this nation preparing to protect our peace, our freedom, our good American way of life.

American Industry has buckled down to its biggest production job since a similar time of need, twenty-odd years ago, and is doing a grand job of it. More clothing, more food, more power, more petroleum *are* already being produced. From eastern to western oceans, vital industrial processes have been stepped up amazingly.

And they have been stepped up confidently, with the absolute assurance that swiftly increased quantity will not mean decreased quality.

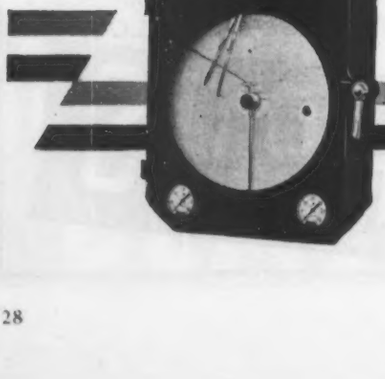
That's where Taylor comes in. Taylor Instruments are helping Industry speed up *safe* production. Taylor Instruments are helping Industry produce to more rigid specifications easily, fully, and economically.

Modern plants use Taylor Instruments—like the great new Taylor Fulscope Controller (the unique five-in-one controller!)—to help make plant operations—manufacturing, processing, or whatever they may be—*automatically* exact, *automatically* foolproof, *automatically* faster and more efficient.

Even in crisis, American Industry *can* be confident. Nowhere else in the world are finer instruments more completely guarding vitally necessary operations.

Taylor is glad and grateful for this vast, unique opportunity to help America "Be Prepared." Uncle Sam *will* be ready. The United States *is* prepared to produce. We *are* producing. Our production is our defense.

Taylor Instrument Companies, Rochester, N. Y. Plant also in Toronto, Canada.



The new Taylor Fulscope Controller helping Industry's huge preparedness program

BE PREPARED WITH **Taylor**

Indicating Recording · Controlling

TEMPERATURE, PRESSURE, FLOW and LEVEL INSTRUMENTS

YOU'VE BEEN ASKING FOR HIGH-VOLTAGE OIL-IMMERSED CONTROL LIKE THIS!

CHECK Its Features against Your Requirements *for:*

EASE OF INSTALLATION

Designed for wall or rack mounting. Needs only four bolts. The cast-iron head, a new feature, keeps the case away from the wall and enables you to make rigid conduit connections from top, bottom, or either side. Power and control terminals are clearly identified and accessible for making connections. Two stainless-steel tank holders provide a simple means for attaching tank.

LOW MAINTENANCE

All operating parts, including overload relays, are immersed in oil. Corrosive fumes cannot get at them. Cast-iron head, mentioned above, resists corrosive moisture that may condense on it. Case is copper-bearing steel painted with aluminum paint. Contactor is of husky construction and contacts are heavy copper.

EASE OF INSPECTION

The operating devices are easily accessible, particularly when the optional tank-lowering mechanism is used. This improved mechanism enables one man to lower and raise tank evenly and accurately with very little effort.

PROTECTION

Thermal overload relays, specially designed for operation in oil, protect motor against damage from excessive overloads. They are mounted with contacts at bottom or side to prevent possibility of oil sludge interfering with their action. Undervoltage protection safeguards machines and operators from danger of unexpected restarting after a power interruption. Control and power wiring are widely separated and securely attached to provide maximum protection to operators.

FROM every angle—installation, inspection, maintenance, protection—this G-E oil-immersed starter is *the* motor control for high-voltage service in the corrosive atmospheres of refineries and chemical plants.

Developed to meet specific operating requirements, it is another example of how G-E engineers take the ideas and suggestions of users and incorporate them into improved products such as you expect of a progressive manufacturer.

As you consider its various features, remember that this starter is but one of a line of oil-immersed control that is as complete as you will find anywhere. General Electric is in a position to furnish low-voltage types, as well as high-voltage units with either high or moderate interrupting capacity. This control can also be furnished with contactor and terminals six inches under oil to make it suitable for installation in hazardous gas locations.

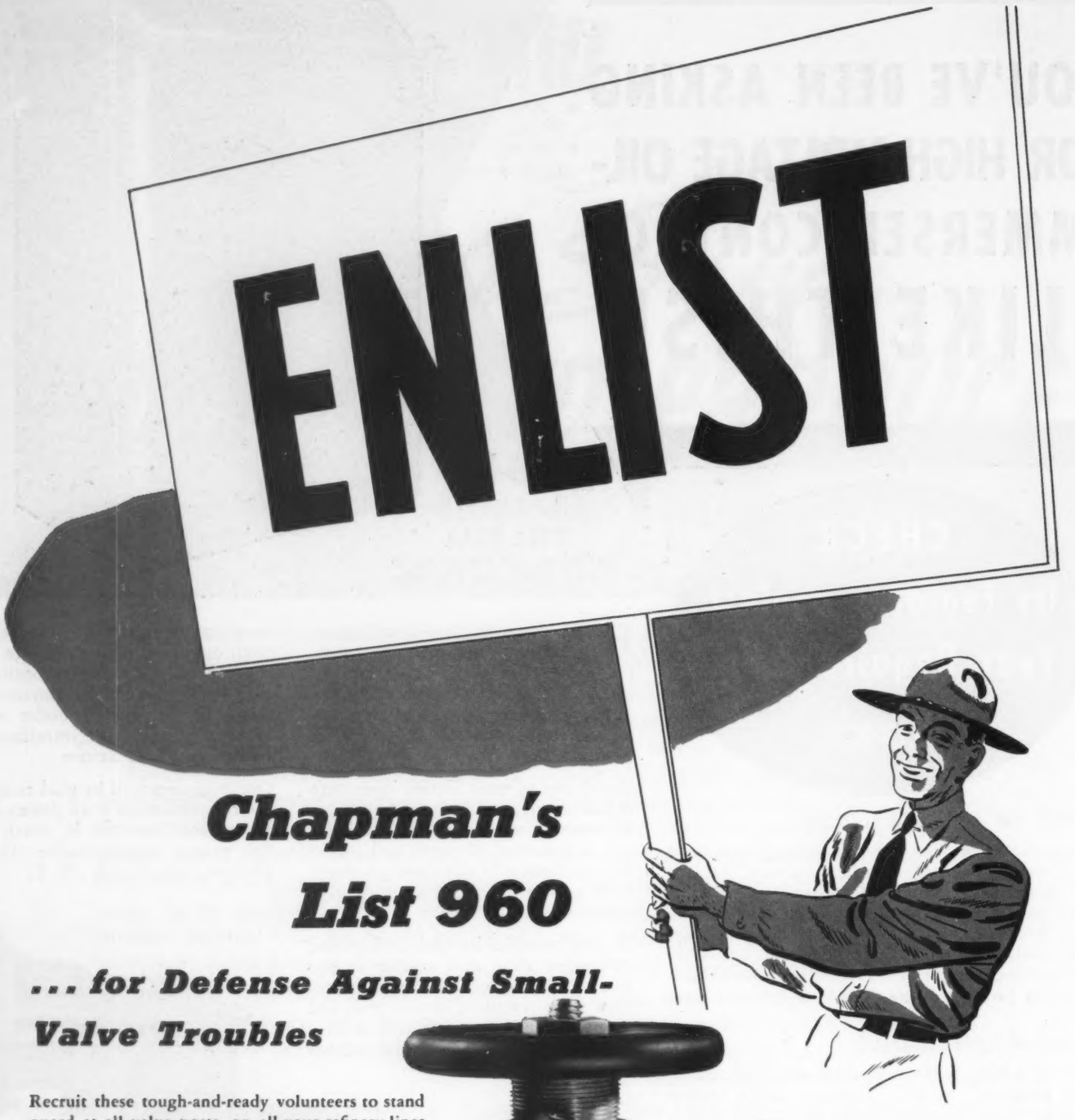
Our engineers will be glad to discuss your requirements with you and your contractor. Just get in touch with our nearest representative. General Electric, Schenectady, N. Y.

▲ The cast-iron head design enables you to wire from top, bottom, or either side

When in service, this operating mechanism is completely oil immersed

The improved tank-lowering mechanism facilitates inspection

GENERAL ELECTRIC

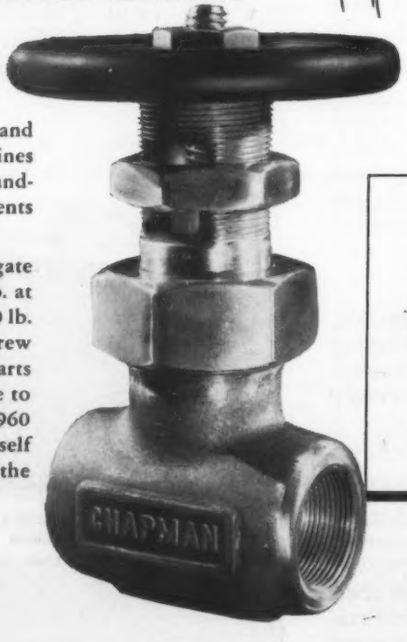


Chapman's List 960

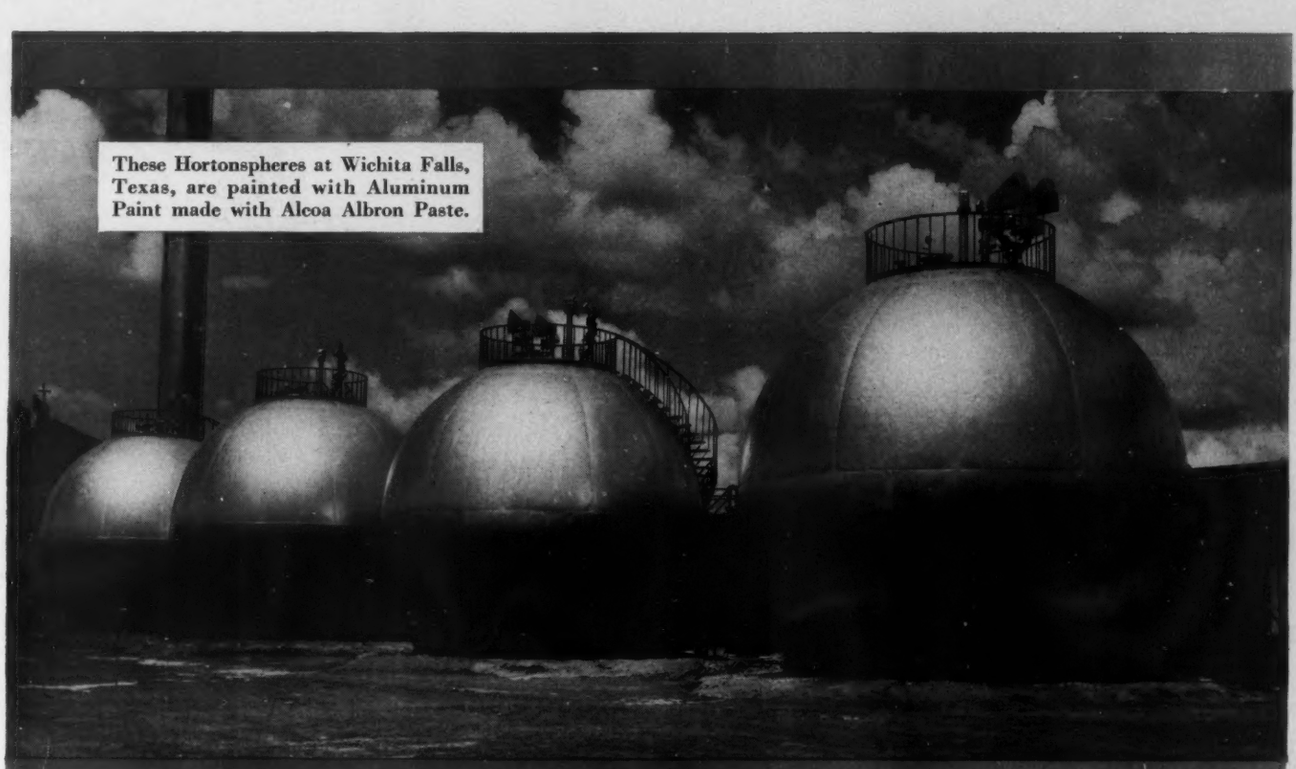
... for Defense Against Small-Valve Troubles

Recruit these tough-and-ready volunteers to stand guard at all valve posts, on all your refinery lines from ¼" to 2". They'll fight trouble to a standstill for 5 years, without any repairs, replacements or reinforcements.

These service-proved, *guaranteed,* forged-steel gate valves are made for all pressures up to 800 lb. at 750°, and for cold working pressures up to 1500 lb. Two rising-stem models: outside and inside screw ... both with screw ends for threaded pipe. Parts are of stainless steel, for which you don't have to carry replacement stocks. Let Chapman's List 960 take command of your lines ... and save yourself money and trouble. Get in touch *today* with the nearest office listed below.



The
Chapman Valve
MANUFACTURING CO.
Indian Orchard, Mass.



These Hortonspheres at Wichita Falls, Texas, are painted with Aluminum Paint made with Alcoa Albron Paste.

Strings for 2 fingers

If you want maximum life and lasting reflectivity, there are two things to remember when you buy Aluminum Paint:

1 ***Specify the right vehicle.*** When you're painting tanks, towers, or any other outdoor metal, you have to use Aluminum Paint that's meant for outdoor metal. Such paint requires a vehicle that's durably elastic and has good body.

2 ***Insist on plenty of pigment.*** It takes two full pounds of top-grade Aluminum paste to the gallon to give you maximum coverage, good hiding, lasting reflectivity, and easy brushing. Specify Alcoa Albron Paste, and you can be *sure* of good results.

With the right vehicle and the right amount of good pigment, your Aluminum Paint will maintain high reflectivity and stand up for years against the worst beating the weather can give it.

ALUMINUM COMPANY OF AMERICA, 1950 Gulf Building, Pittsburgh, Pa.

We make Aluminum pigments only; no Aluminum Paint. Aluminum Paints of high quality are made by leading paint manufacturers who use Alcoa Albron Paste, manufactured by Aluminum Company of America under patents of Metals Disintegrating Co., Inc.

ALCOA ALUMINUM

ALBRON *Paste for* ALUMINUM PAINT

CURBS CORROSIVE ACIDS

You know what a curb bit does to an unruly horse—gentles it—helps bring it under control.

Tellurium Lead has the same effect on corrosive acids. From many different industries come user reports telling how this lead has subdued trouble-making acids—reports which state that Tellurium Lead has prolonged the life of equipment, even when the temperature has approached the melting point of the metal.

Another highly important property of Tellurium Lead is this: *It toughens under stress.* When rolled, stretched or hammered, it actually becomes stronger. As a result, turnover points and joints are less subject to cracking. Furthermore, where vibration occurs, this capacity to develop latent strength minimizes buckling and creeping. It also gives Tellurium Lead improved resistance to fracture due to repeated heat changes.

Tellurium Lead of our manufacture is time-tested St. Joe chemical lead alloyed with a small quantity of tellurium. It gives the advantages of this well-known chemical lead plus important new ones. Yet now it costs only a fraction of a cent more per pound than chemical lead. Available in sheets, pipe and coils. For further facts, write our nearest branch.

NATIONAL LEAD COMPANY

New York, Baltimore, Buffalo, Chicago, Cleveland, Cincinnati, St. Louis; National-Boston Lead Co., Boston; John T. Lewis & Bros. Co., Philadelphia; National Lead & Oil Co., Pittsburgh; Georgia Lead Works, Atlanta; American Lead Corp., Indianapolis; Master Metals, Inc., Cleveland; The Canada Metal Co., Ltd., Toronto, Montreal, Winnipeg, Vancouver.

FROM HOW FAR CAN YOU SEE THIS LIQUID LEVEL ?

At the right is shown a reproduction from an actual unretouched color photograph which illustrates the appearance of the gauge glass from directly in front.

HERE'S a real test of liquid level visibility! Place this gauge glass illustration next to the gauge glass you are now using. Then observe both from varying distances. Note the superior visibility of the liquid level in the illustration and remember—the illustration is a poor substitute for the vivid, unmistakable, liquid level visibility of an actual "PYREX" Broad Red Line Gauge Glass.

But visibility alone is not enough. A gauge glass that will give a long life of economical service must have machine drawn accuracy that avoids installation strains; chemical stability that resists the solvent action of steam; resistance to sudden temperature changes; mechanical strength that reduces breakage. That's exactly what you get in all "PYREX" Gauge Glasses.

An actual test of the gauge glass itself is your best proof of its true value. Your dealer will gladly cooperate. Ask him for full details. "PYREX" and Corning Gauge Glasses are stocked by leading steam and mill supply houses. Corning Glass Works, Corning, N. Y.

CORNING
Glass Works
Corning, New York

Pyrex Gauge Glasses

"They Just Don't Break!"

. . . . that's what users say about these Galvanometer Suspensions!

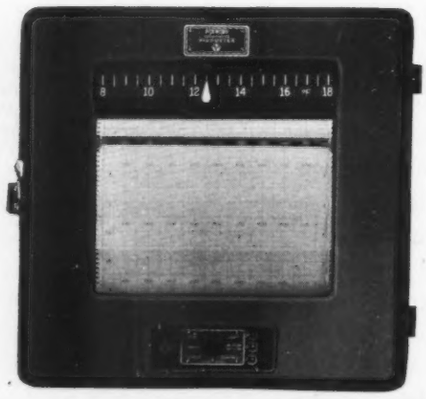
Did you ever see a year or more pass without a single galvanometer suspension replacement in a bank of operating pyrometers?

Several large-scale users of Foxboro Potentiometer Recorders and Controllers have reported this experience. They told us not to bother sending spare suspensions with new instruments on order!

Foxboro galvanometer suspensions are so designed that breakage practically never occurs. Their acid-proof gold strips are longer, heavier, stronger . . . spot-welded, instead of soldered in place. And their end-brackets are made with smoothly-crowned snubbing surfaces that stop destructive shear action.

Yet this is only one of numerous refinements that make Foxboro Potentiometer Instruments more sensitive and more economical to maintain. Other original Foxboro features make possible instant, accurate response with *slower* movement of elements and *fewer* moving parts to wear out!

Get the complete story on these trouble-free instruments. Write for Bulletin 190-4. **The Foxboro Co., 74 Neponset Ave., Foxboro, Mass., U. S. A.** Branches in principal cities of United States and Canada.



Foxboro Potentiometer Recorders and Recording Controllers are guaranteed accurate within ¼ of 1% of scale range.

— RECORDING · CONTROLLING · INDICATING —

FOXBORO
REG. U. S. PATENT OFFICE

Potentiometer Instruments

Color Cast Carbon

THE renewed emphasis of buyers on these three characteristics makes it important for every lube refiner to reconsider NOW whether his present methods are getting the needed results, and if so, what it is costing. Some methods greatly improve one characteristic without affecting one or both of the others. Other methods improve two of these specifications but actually harm the third.

BUT, there is one method of improving all three at one and the same time. It is high temperature contacting with SUPER FILTROL. This has been proven time and again, and now it is being used by leading refiners at lower cost than ever.

CONSIDER the figures below and the unretouched color photograph, then write Filtrol Corporation. We will be glad to work up data on your stocks to demonstrate the low cost and ease of meeting the stepped up demands of today when SUPER FILTROL is called on to do the job.

	SUPER FILTROL Used Lbs./Gal.	A.S.T.M. Color	Conradson Carbon
Pennsylvania Cylinder Stock before treatment...		darker than 8	2.06
Contacted at 550° F.....			
20 minutes 550° F.....	0.35	7	1.80
20 minutes 550° F.....	0.60	6½	1.65
20 minutes 550° F.....	1.00	6	1.54

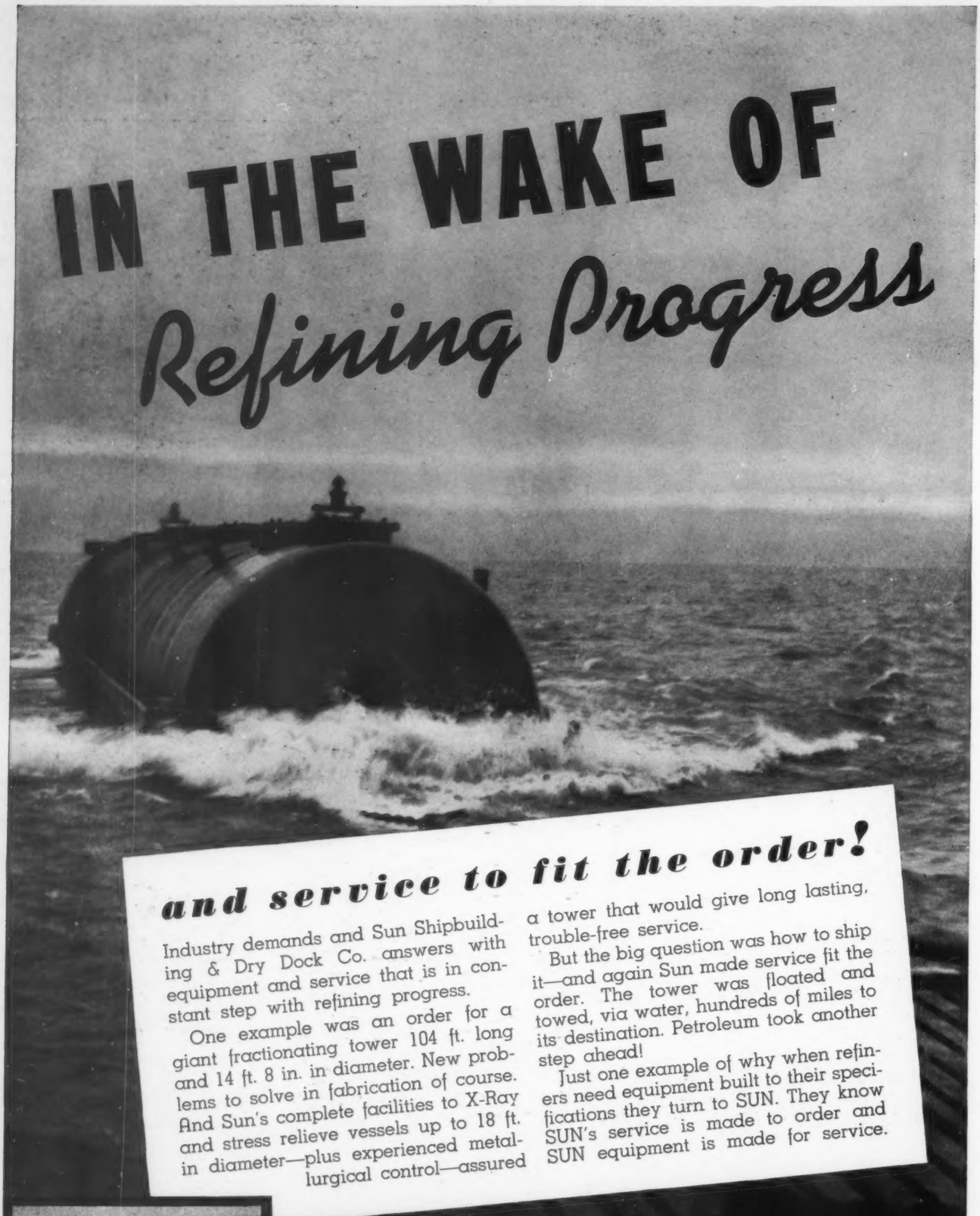
FILTROL CORPORATION

GENERAL OFFICES:
315 WEST FIFTH STREET
LOS ANGELES, CALIF.

PLANTS:
VERNON, CALIFORNIA
JACKSON, MISSISSIPPI

CABLE ADDRESS: FILTROL • LOS ANGELES

AGENTS AND WAREHOUSE STOCKS IN PRINCIPAL REFINING CENTERS OF THE WORLD



IN THE WAKE OF *Refining Progress*

and service to fit the order!

Industry demands and Sun Shipbuilding & Dry Dock Co. answers with equipment and service that is in constant step with refining progress.

One example was an order for a giant fractionating tower 104 ft. long and 14 ft. 8 in. in diameter. New problems to solve in fabrication of course. And Sun's complete facilities to X-Ray and stress relieve vessels up to 18 ft. in diameter—plus experienced metallurgical control—assured a tower that would give long lasting, trouble-free service.

But the big question was how to ship it—and again Sun made service fit the order. The tower was floated and towed, via water, hundreds of miles to its destination. Petroleum took another step ahead!

Just one example of why when refiners need equipment built to their specifications they turn to SUN. They know SUN's service is made to order and SUN equipment is made for service.

SUN SHIPBUILDING & DRY DOCK CO.
CHESTER, PENNSYLVANIA

"THESE NEW STAINLESS TRAYS WILL SAVE US THOUSANDS OF DOLLARS"

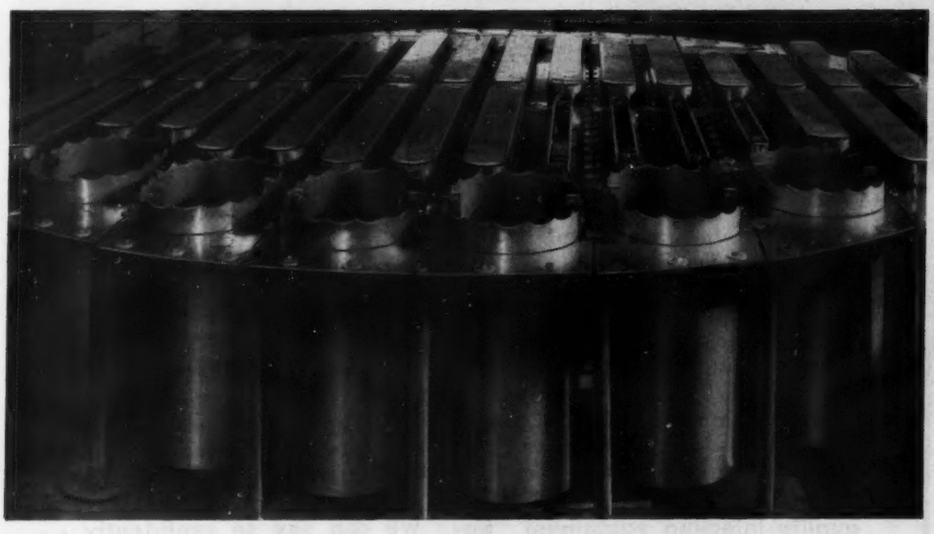
. . . predicts prominent refiner after inspecting year-old trays

IT was a little over a year ago when engineers of this refinery decided to put a stop to the frequent interruptions in service of their bubble tower. Altogether too often had come the reports "Off stream to replace trays," "Off stream to clean out coke," "Off stream for repairs." Every day off stream was costing the refinery about $3,000.

To end these costly service interruptions, they recommended five new bubble trays and eight new side-to-side trays, fabricated of 16, 14, and 12-gage U·S·S Stainless Steel. These were installed, and today, after a year of practically continuous operation, comes the report:

"All lightweight stainless trays in perfect shape. No evidence of corrosion or coking. Estimate they will save thousands of dollars, as they appear good for indefinite service."

Ask us for complete facts on this money-saving innovation. Write for names of fabricators qualified to aid you in the design and construction of lightweight bubble trays of U·S·S Stainless Steel. Take the first step today.



LIGHTWEIGHT STAINLESS TRAYS OFFER IMPORTANT ADVANTAGES

1. FREEDOM OF DESIGN. Stainless puts no limitations on the designer's ingenuity. Structurally strong and easy to fabricate, it enables you to employ the newest design principles, to pack more capacity within a given space, to increase thermal efficiency, to reduce overall weight, to reduce foundation costs.

2. SPEEDY INSTALLATION. Properly designed, the trusses, beams, and other structural members employed in stainless bubble trays are light in weight, easy to handle, safer to workmen. Example: One 12½-ft. tower was equipped with five bubble trays and eight rain decks in 48 hours. (It would have taken 10 days to install ordinary trays.)

3. PREVENTS "COKING." Stainless trays and bubble caps have thus far proved immune to coking. In tests stainless caps were mounted beside ordinary caps. The ordinary caps coked badly, while the stainless caps showed no coking at all. Probable explanation for this is the hard, smooth stainless finish.

4. RESISTS CORROSION. Even sour, high-sulphur crudes, which are highly corrosive to ordinary bubble trays, and often require premature replacement, have so far caused no ill effects on stainless bubble trays now in service.

5. WITHSTANDS SUDDEN SHOCKS. The inherent flexibility of lightweight stainless construction enables properly designed trays to withstand sudden shocks or pressure surges, such as water shots or "bumps." In a very serious explosion, the stainless trays might bend or tear, but they could be salvaged cheaply. A serious explosion usually reduces ordinary trays to scrap.

6. FASTER HEATING AND COOLING. Because of the low heat capacity of lightweight stainless construction, towers so equipped take less time to be put on stream, and less time to be taken off stream for inspection or clean-out. This property saves much production; which, at $1,000 to $10,000 a day, represents a valuable saving.

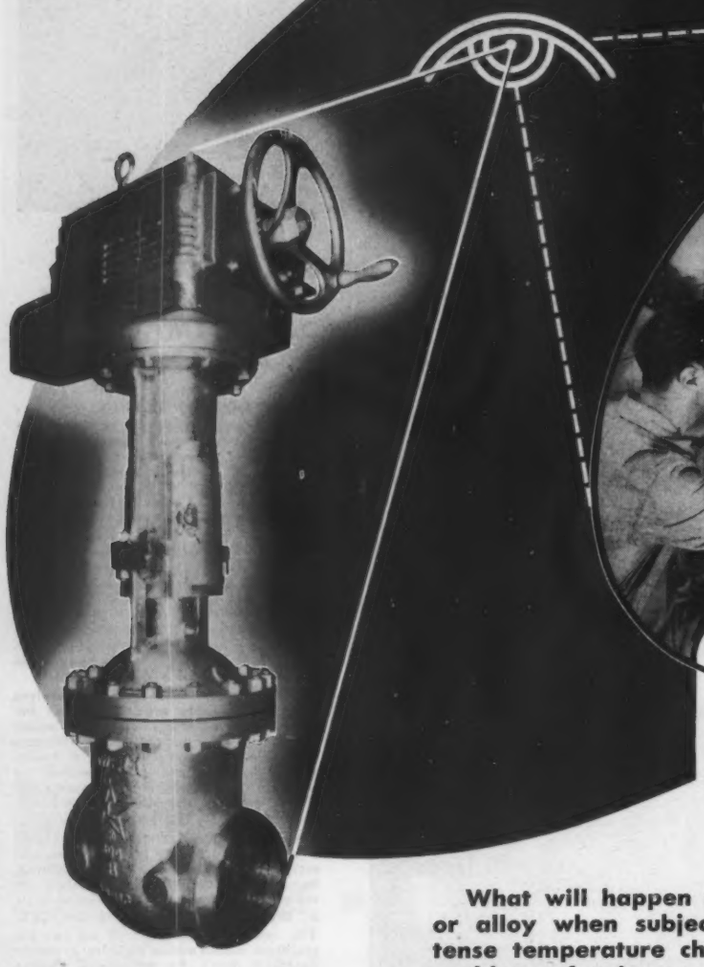
U·S·S STAINLESS STEEL

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
NATIONAL TUBE COMPANY, *Pittsburgh*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* • United States Steel Export Company, New York
Scully Steel Products Company, Chicago, *Warehouse Distributors*

UNITED STATES STEEL

There's more to POWELL QUALITY than meets the BUYER'S EYE!



READY···AIM···FIRE!

Here's a "Big Gun" in Our Own Preparedness Campaign, Making Powell Valves Safe for Severest Temperature Services

What will happen to a metal or alloy when subjected to intense temperature changes is a problem of primary importance when designing valves for extraordinary services. The degree of expansion or contraction which takes place under given conditions has everything to do with the valve's operation, performance, and all-over economy.

One of the many pieces of quality-injecting equipment "behind the scenes" at Powell is this intricate laboratory trouble-shooter, called the Dilatometer. With unfailing accuracy, it obtains critical points of metals when subjected to temperature and determines coefficients of expansion . . . two vital factors in anticipating the true behavior of Powell Valves when eventually put into service on your property.

It's just one link in a long chain of unseen operations underlying the greater inherent quality of these preferred products, but the Dilatometer is one of the reasons we can say so confidently . . . "there's more to Powell quality than meets the buyer's eye!" Won't you give it a thought next time you're in the market for the best valve performance money can buy?

You Need More Than a Photograph of the Finished Product to see ALL the Qualities that Make Powell Valves Uniquely Able to Better Serve Your Requirements

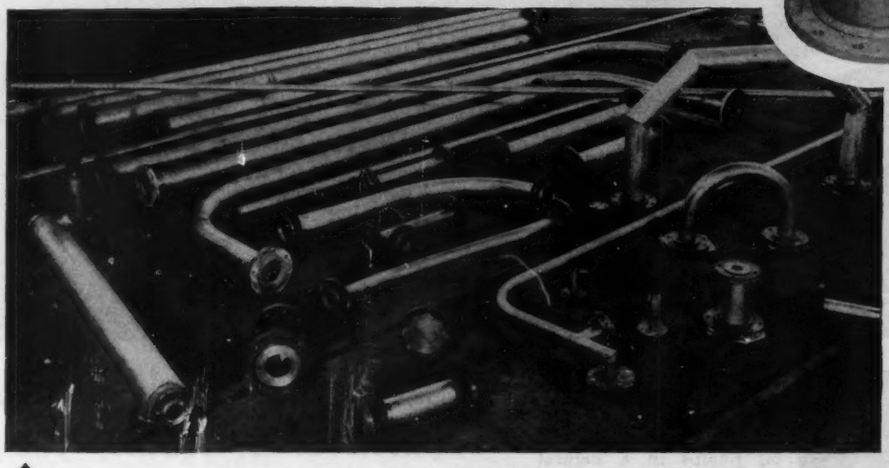
THE WM. POWELL COMPANY
CINCINNATI, OHIO

POWELL VALVES

LESS CORROSION

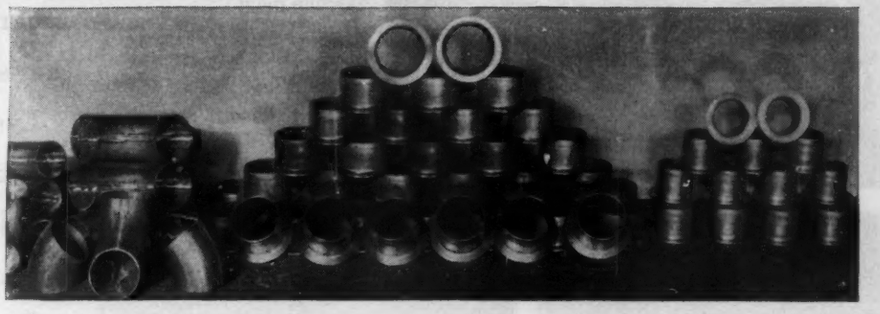
IN PIPE AND FITTINGS WHEN MADE OF MONEL...

Available in all usual forms and easy to weld, this durable material permits wide latitude in design



How easily all-Monel fittings can be fabricated is shown by these spool pieces made for a refinery disposal plant. The pipe is made from Monel sheet, welded at seam, then welded to flanges of cast Monel. Made by Robinson Engineering Company, Garwood, N. J.

There is practically no limit to the type of fitting you can make with Monel. In this photo, for example, are shown seamless and welded pipe, couplings, elbows, return bends and other shapes. Of all-welded Monel construction, they were made for a large eastern refinery by Zallea Brothers & Johnson, Wilmington, Delaware.



An easy metal to form, Monel is well suited for shapes such as these welding elbows and Van Stone necks. All are of welded Monel construction, fabricated by Robinson Engineering Company, Garwood, N. J., for a refinery disposal plant.

• • •

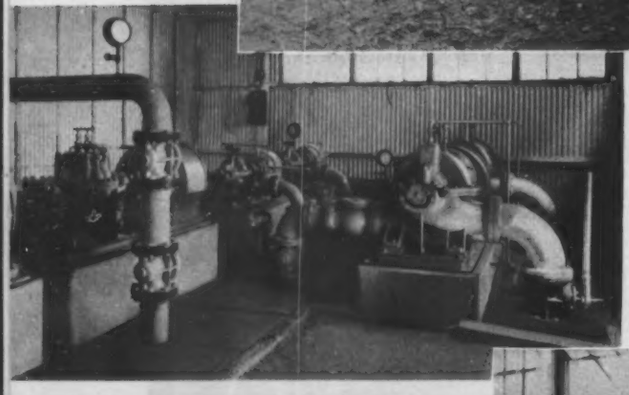
Monel possesses exceptional toughness, strength, and resistance to refinery corrosives. In addition to pipe lines, this long-lived metal is widely used for heat exchangers, linings of upper tower sections, top bubble caps and trays, pump rods and shafts and other applications at temperatures under 500°F.

In ordering such parts specify Monel. Write for full information on this popular refinery metal. Ask for Bulletin C-2, "Monel and Nickel in Oil Refining." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

REFINERIES EVERYWHERE FIND THAT
INGERSOLL-RAND PUMPS
STAY ON THE JOB

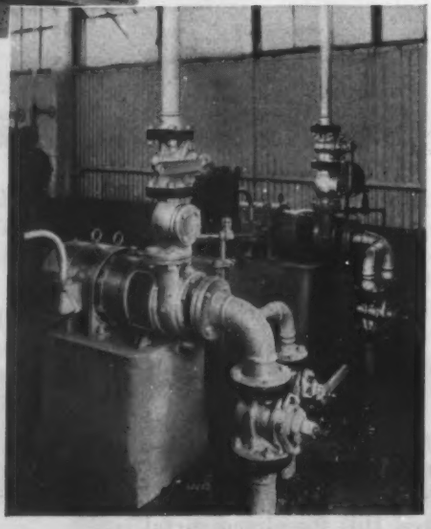


(Above) Class AHT charging viscosity breaker unit at a refinery in Texas.

(Left) Rich oil and lean oil pumps in a natural gasoline plant.

(Lower left) 2-stage pumps in a natural gasoline plant.

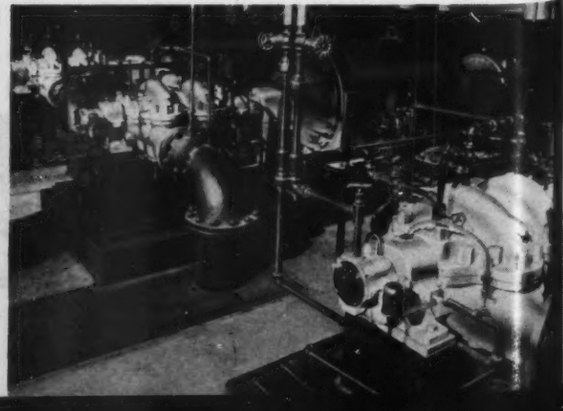
(Below) Motorpumps on reflux service in a refinery.



Ability to stay on the job is a primary requirement for refinery pumps. Ingersoll-Rand refinery pumps have that ability.

Every pump in the complete I-R line has been designed by engineers and metallurgists with long experience on refinery jobs. The success of these pumps in refineries all over the world proves their efficiency and dependability.

(Below) 2-stage pumps handling crude oil in a refinery.



Ingersoll-Rand

Cameron Pump Division

11 BROADWAY NEW YORK, N. Y. 785-10

Pittsburgh, Pottsville, Salt Lake City, San Francisco, Scranton, Seattle, St. Louis, Tulsa, Washington

Detroit, Dublin, El Paso, Hartford, Houston, Kansas City, Knoxville, Los Angeles, Newark, New York, Philadelphia, Picher

KEEPING ABREAST OF INSULATION NEEDS IN THE *FAST-MOVING REFINERY INDUSTRY...*

Almost ***overnight*** modern refinery advancements have made new demands on insulating materials... but Eagle-Picher has kept pace—has developed *improved* insulations made from a sensational dark gray mineral wool.

Petroleum engineers are quick to recognize the special advantages of this dark gray wool in meeting present-day problems. It has two unique features which bring special savings...

It is chemically inert. Moisture does not cause this distinctively dark mineral wool to deteriorate—an important feature in maintaining its stability.

Its fibers are extremely resilient and flexible. This mineral wool therefore withstands expansion and contraction without deterioration or loss of efficiency.

Special Service. Just as Eagle-Picher has kept pace on the making of insulations having maximum efficiency, Eagle-Picher has also developed a skilled Contracting Service to help you on problems of specifying and applying insulation. On your next job, call on Eagle Contracting Service... make sure you get the right insulation for every part of your equipment, installed in the most effective way by specialists.

FOR FURTHER INFORMATION SEE OUR CATALOG IN SWEET'S

EAGLE INSULATION FOR OIL REFINERIES

Eagle Blanket Insulation. For temperatures as high as 1200° F. Made of resilient mineral wool—withstands expansion, contraction and other service conditions without deterioration.

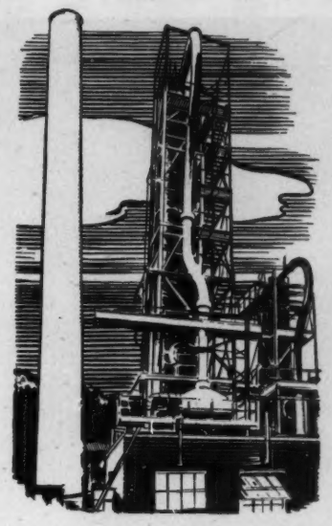
Eagle Super "66" Plastic Insulation. For temperatures as high as 1800° F. Extremely high coverage—minimum shrinkage. Great adhesiveness, easy to apply.

Eagle Insulseal. Durable finish to protect all kinds of heat insulation against air infiltration, moisture, water, fumes. Withstands severe service—protects against vibration and abrasion.

Also designed specially to deal with high temperatures are many other Eagle Products, including Eagle Supertemp Blocks, Eagle Pipe Coverings, Eagle Insul-Stic.

EAGLE PICHER

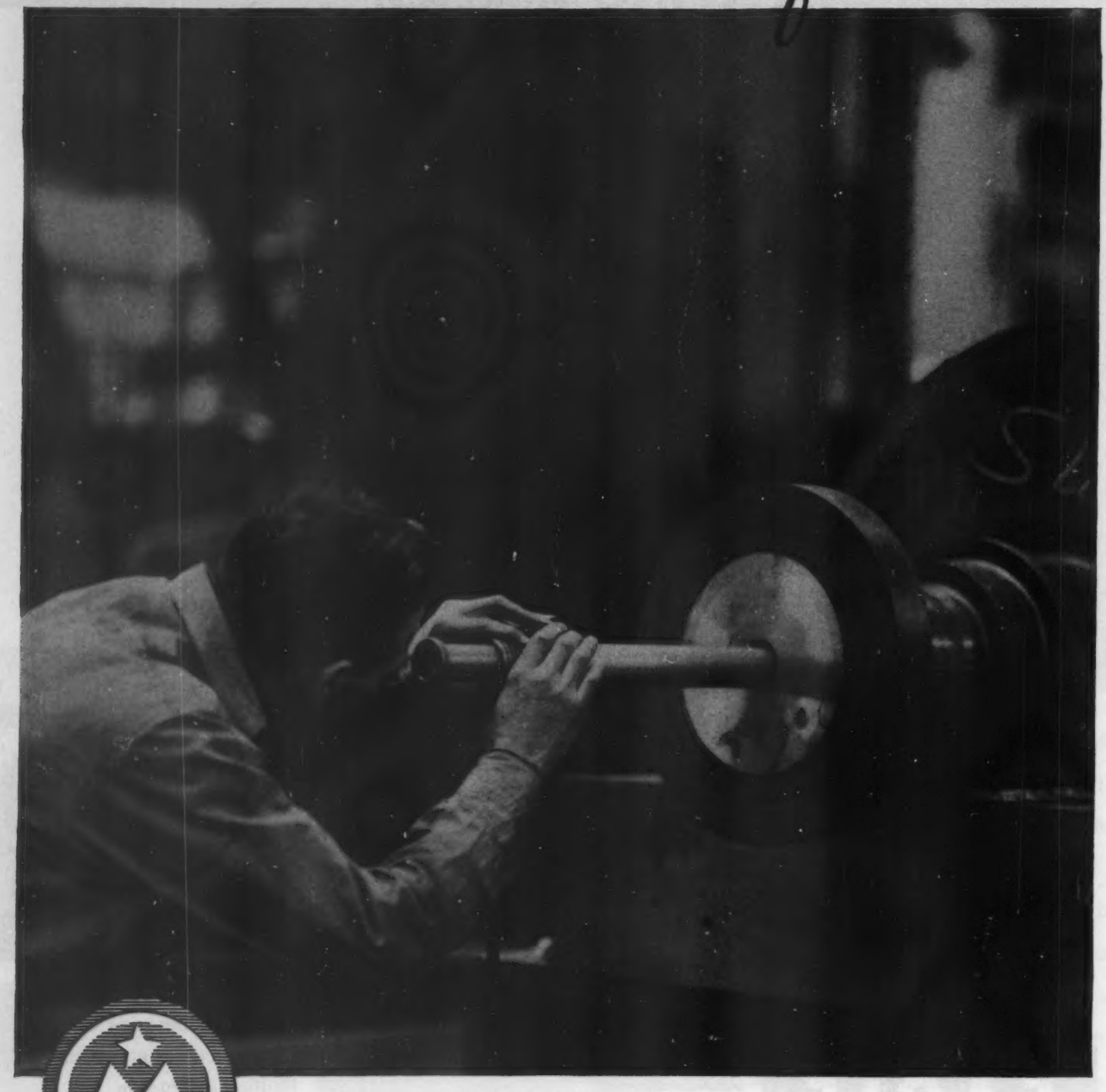
THE EAGLE-PICHER LEAD COMPANY, CINCINNATI, OHIO



Most Leading Refineries now use Eagle Insulating Materials. Among them are...

Bay Refining Corporation
British American Oil Company
Canfield Oil Company
Danciger Refineries
Elk Refining Co.
Farm Bureau Refining Company
Frontier Fuel Oil Corporation
Louisville Refining Co.
Lubrite Corporation
Midwest Refineries Co.
Old Dutch Refining Co.
Phillips Petroleum Corporation
Producers Refining, Inc.
Pure Oil Company
Quaker States Oil Company
Shell Petroleum Corporation
Socony-Vacuum Oil Co.
Southport Petroleum Corporation
Tidewater Associated Oil Co.
Trumbull Asphalt Plant (Oil Division)

MIDVALE *Craftsmen*

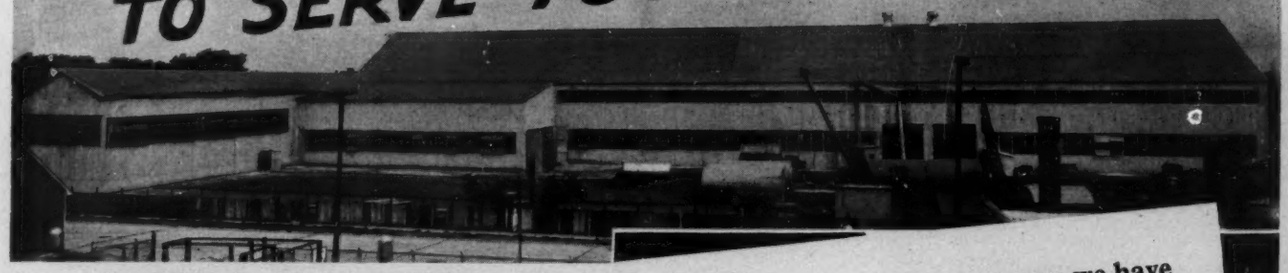


PRECISION today is as vital in big things as in little. In some ways more vital—as its lack can be more costly. Large moving parts require rigid inspection that is literally microscopic—and Midvale experience, equipment and men know how to produce just this.

THE MIDVALE COMPANY • NICETOWN • PHILADELPHIA, PA.

OFFICES: *New York • Chicago • Pittsburgh • Washington • Cleveland • San Francisco*

AT YOUR Service! TO SERVE YOU Better!



Exterior view of modern assembly buildings.

Interior view of main assembly building. Length, 380 ft.—Width, 87 ft.

Interior view of fitting-up aisle, showing several tanks on fitting-up racks.

FOR more than seventy-five years we have been serving industry with steel plate equipment fabricated to give the utmost efficiency and dependability.

During these years we have earnestly tried to keep in step with progress—tried to do a good job *Better*, and we know that we have succeeded—thanks to you and hundreds of others.

Today, we are better prepared than ever to carry on—to uphold the almost century old tradition which is the heritage of every Graver employee from office boy to president.

Now, complete, new assembly buildings, equipped with all of the latest tools, including automatic welding equipment, enable us to serve industry with an even greater degree of efficiency. So, we are AT YOUR SERVICE—to serve you BETTER. Need more be said?

STEEL OR COMPOSITE METAL TANKS
FOR STORAGE OR PROCESSING

SPECIAL TANKS FOR CONSERVATION OF GASOLINE
WATER SOFTENERS • FILTRATION SYSTEMS • CLARIFIERS
FABRICATED STEEL AND NON-CORROSIVE COMPOSITE PLATE

GRAVER CONSTRUCTION DIVISION
A COMPLETE DEPARTMENT FOR ERECTION OF PROCESSING EQUIPMENT
Full details concerning this service may be secured upon request

GRAVER TANK & MFG. CO., INC.

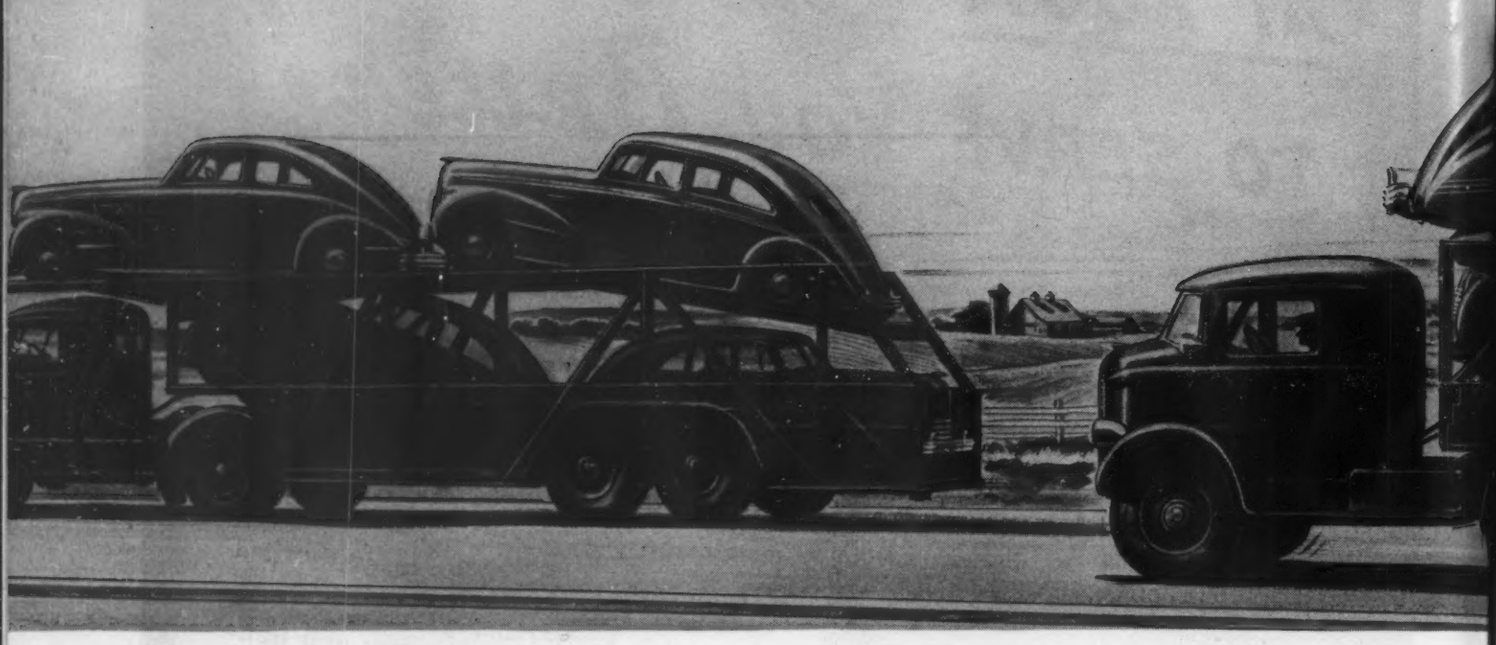
OVER THREE QUARTERS OF A CENTURY OF DEPENDABLE SERVICE

NEW YORK
CATASAUQUA, PA.

EAST CHICAGO, IND.
CABLE ADDRESS—GRATANK

CHICAGO
TULSA

New Cars Reflect



1941 MODELS SHOW CONTINUATION OF TREND IN ENGINE DESIGN TO UTILIZE HIGHER ANTI-KNOCK GASOLINE

THE MARKED INCREASE in the compression ratios of 1941 cars —the sharpest rise in five years—is ample evidence that automobile manufacturers are keeping pace with advances in gasoline anti-knock quality. The compression ratios for all makes and models of 1941 cars average 6.66 to 1, as against 6.43 to 1 for 1940. At least twenty-five of the new models have higher compression ratios than they did last year, and some manufacturers who have not increased their already high compression ratios have made other changes in engine design to obtain additional horsepower from today's greatly improved fuels.

How closely increases in engine efficiency have paralleled gains in gasoline anti-knock value in recent years is shown in Figures 1 and 2. Improvements in motor fuel have made it possible for automotive designers to stress efficiency rather than size—a trend which in all likelihood will continue. Future developments in automotive engine designs will probably follow lines already successfully established in both automotive and aviation practice: the improvement of performance and fuel economy through further increases in compression ratios or by supercharging or both.

Figures 3 and 4, based on laboratory tests made on a 1940 model vehicle, show the gains in fuel economy, car speed and acceleration made possible by simultaneously raising the compression ratio from 6.1 to 1 to 8.6 to 1 and the fuel octane number from 78 to 95. And Ethyl research workers are now experimenting with engines having compression ratios above 11 to 1 and requiring fuel of over 100 octane number. Tests with supercharged engines also are being conducted. (Fig. 5.)

Engines and fuels are so closely related that their development is a joint responsibility of the automotive engineer and the petroleum technologist. Through their cooperative efforts, suitable fuels of higher anti-knock quality will be produced economically for engines which will utilize them with greatest efficiency.

We of the Ethyl Gasoline Corporation, through our research laboratories in Detroit and San Bernardino, are actively cooperating with engine designers in making the best possible use of tomorrow's fuels and with fuel refiners in producing gasolines best suited to the engines of tomorrow.

ETHYL GASOLINE CORPORATION, *Chrysler Building, New York, N. Y.*

Progress in Fuels

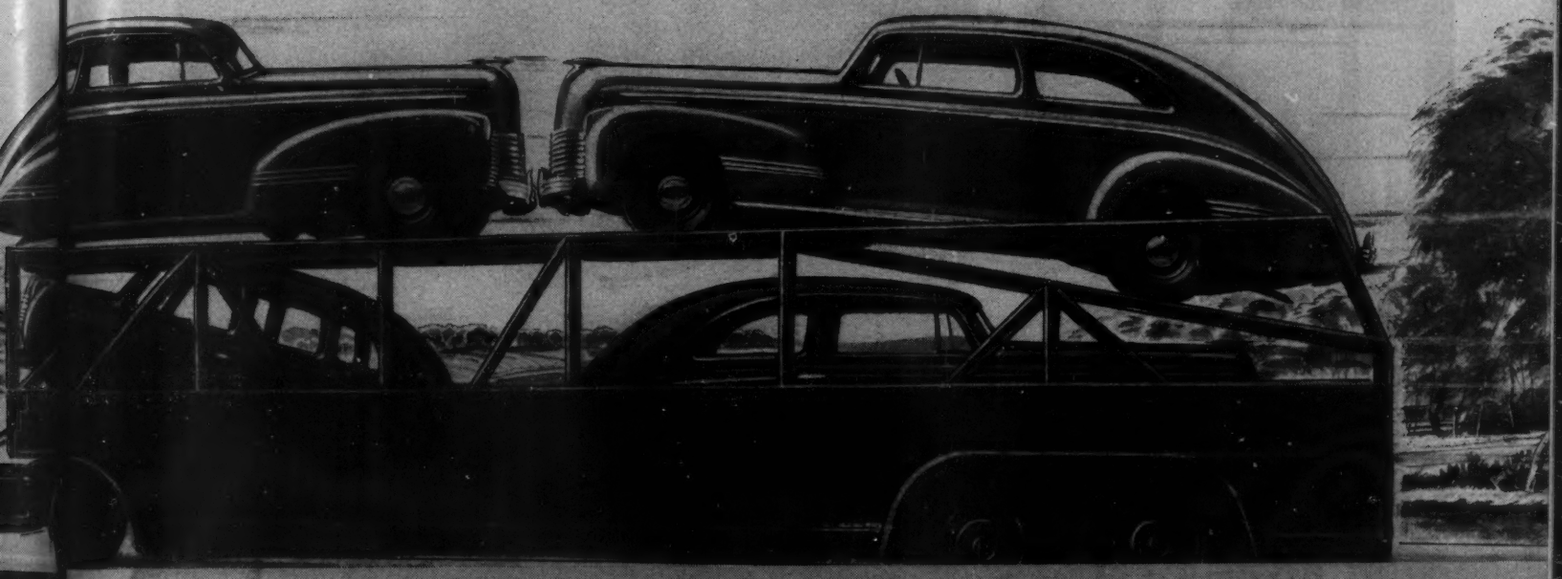


FIG. 1 (*below*) Octane numbers of automotive fuels have risen steadily over the past ten years. It is interesting to note that the regular gasoline being marketed today is superior in anti-knock quality to the premium gasoline of 1933.

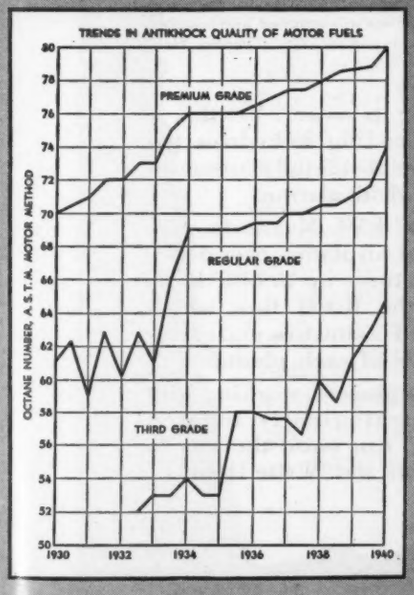


FIG. 5 (*right*) In laboratory tests on an eight-cylinder valve-in-head engine, supercharging to the limit permitted with 90 octane gasoline resulted in maximum brake horsepower of 145, as compared with 80 horsepower and an octane number requirement of 78 unsupercharged. Specific fuel consumption was substantially unchanged by supercharging.

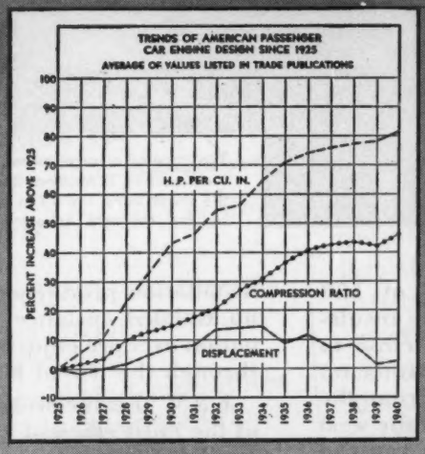
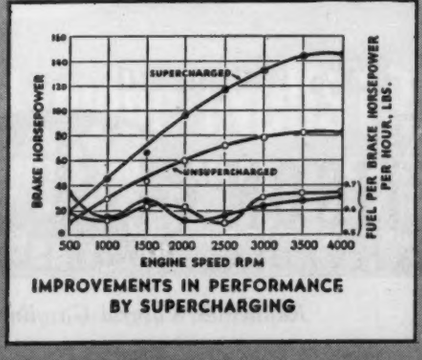


FIG. 2 (*above*) The trend of American passenger car engine design has stressed efficiency rather than size. The development of fuels of higher anti-knock value will permit designers to continue to improve the efficiency of their engines.



IMPROVEMENTS IN PERFORMANCE BY SUPERCHARGING

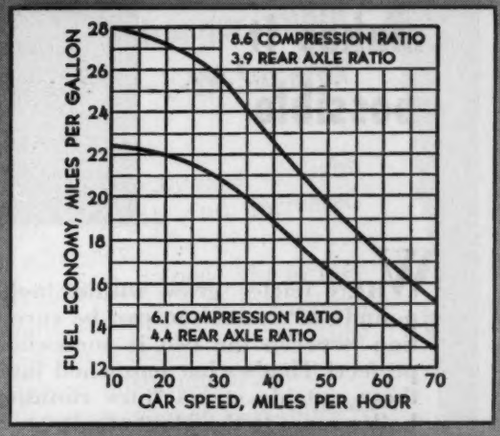


FIG. 3 (*above*) Fuel economy of a 1940 model vehicle at 6.1 compression ratio and 4.4 rear axle ratio compared with fuel economy at 8.6 compression ratio and 3.9 rear axle ratio. Maximum power ignition timing was used with each compression ratio. Accelerating ability at 8.6 compression ratio and 3.9 rear axle ratio is equal to that of the other combination at low speeds and is much better than the other at high speeds.

IMPROVEMENT IN FULL THROTTLE ROAD PERFORMANCE OF A 1940 MODEL CAR WITH 8.6 COMPRESSION RATIO AS COMPARED WITH THE SAME CAR WITH 6.1 COMPRESSION RATIO

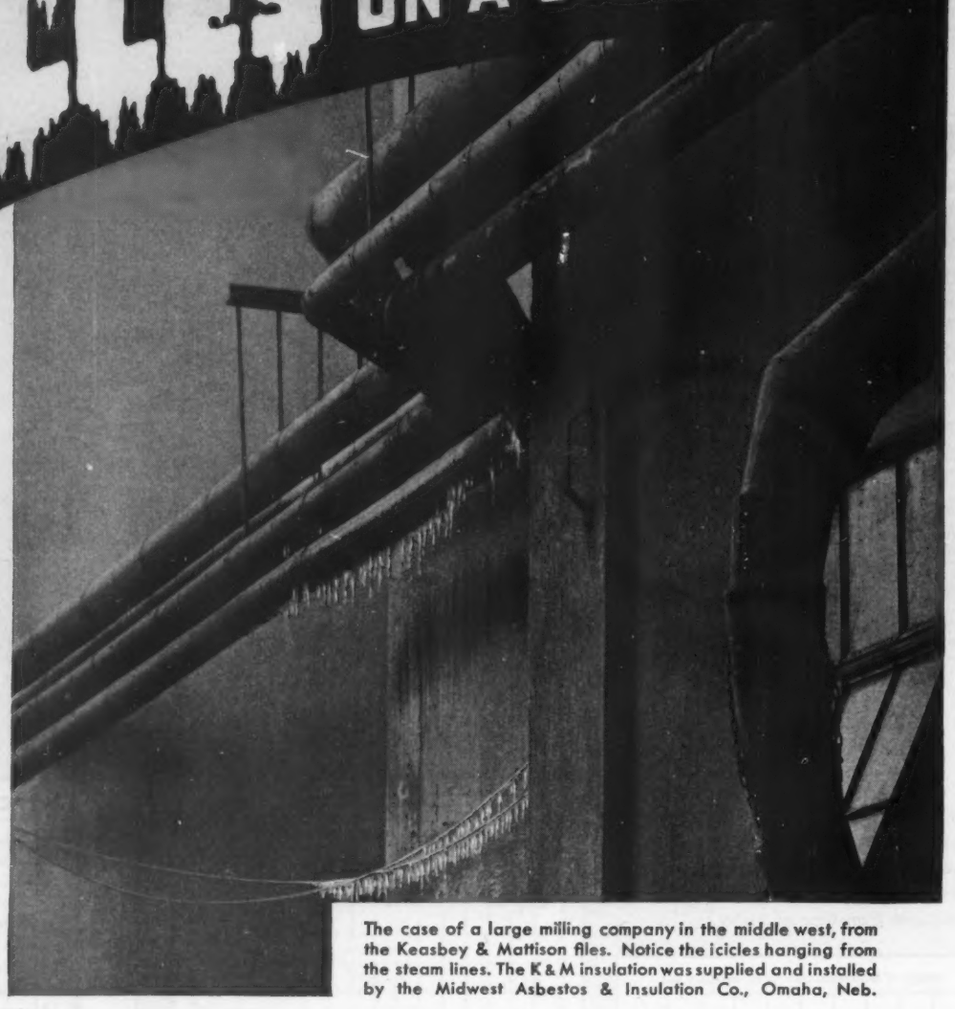
ALL DATA OBTAINED WITH SPARK ADVANCE FOR MAXIMUM PERFORMANCE AND WITH A 4.4 REAR AXLE RATIO

ACCELERATION ON LEVEL ROAD	PERCENT IMPROVEMENT
10 TO 30 M. P. H.	17.2
10 TO 60 M. P. H.	18.0
ACCELERATION ON 11.6% GRADE	
TIME REQUIRED TO CLIMB GRADE	25.8
SPEED AT TOP OF GRADE	67.6
TOP SPEED	5.4

THE FUEL OCTANE NUMBERS FOR "TRACE" KNOCK WITH 6.1 AND 8.6 COMPRESSION RATIOS WERE 78 AND 95 RESPECTIVELY

FIG. 4

ICICLES ON A STEAM LINE...



The efficiency of K&M insulation makes it possible

The case of a large milling company in the middle west, from the Keasbey & Mattison files. Notice the icicles hanging from the steam lines. The K & M insulation was supplied and installed by the Midwest Asbestos & Insulation Co., Omaha, Neb.

WHEN icicles grow within inches of 150 pounds of steam, you can be sure the insulation between the two is somewhere close to perfect! That's what happened last winter on these outside steam lines running from the boiler room to the plant of a large middle west milling company. It is not often that you can actually *see* insulating efficiency, but here is a case where you can.

The credit for this performance goes to Keasbey & Mattison insulations—1200 feet of K&M "Featherweight" 85% Magnesia, plus 350 feet of K&M Wool Felt. This dramatic instance emphasizes the importance of the fuel and dollar savings that this efficient K&M installation produces for its owner. Yet this is no isolated instance. Leading industries the nation over are enjoying substantial economies through the use of K&M insulation.

K&M "Featherweight" 85% Magnesia, one of the most efficient heat insulators ever developed for use at temperatures up to 600° F., is a leading product in the K&M line, which includes magnesia and asbestos materials specialized for the needs of each plant.

Keasbey & Mattison engineers, working with K&M Distributors strategically located throughout the country, can point the way to real savings in your plant, too. Write Dept. 11 for full details.

K&M "Featherweight" 85% Magnesia

"The Time-Proven Insulation"

KEASBEY & MATTISON

COMPANY, AMBLER, PENNSYLVANIA

NOW! A NEW TYPE OF SUPEREX INSULATION!

Out of the J-M Laboratories comes this lighter, stronger, more efficient insulation for temperatures up to 1500° F.—L-W Superex

For temperatures to 600°, J-M 85% Magnesia; to 700°, J-M Asbesto-Sponge Felted; to 1900°, J-M Superex. This has been standard insulation practice in thousands of plants.

Now, for intermediate temperatures up to 1500°, the J-M Laboratories have developed a companion product for these outstanding insulations—the new L-W Superex. Within this temperature range, L-W Superex blocks and pipe insulation provide the durability and permanence so characteristic of all J-M Insulations, with the added advantages of light weight, high strength and increased insulating efficiency.

Between 1500° and 1900°, the former Superex, now known as H-T Superex, still remains No. 1 choice for reliability and maintained efficiency in service.

Detailed information on L-W Superex is now available in engineering data sheets. For your copies and facts on the complete line of J-M Insulations, just write Johns-Manville, 22 East 40th Street, New York, N. Y.

JM Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE . . .

L-W Superex Blocks and Pipe Insulation . . . H-T Superex Blocks . . . Asbesto-Sponge Felted . . .
85% Magnesia . . . Sil-O-Cel C-22 Brick . . . Rock Cork . . . JM-20 Brick

CONDENSER TUBES

CAN LAST LONGER

AT

NO EXTRA COST

New Chase Alloy, Antimonial Admiralty, Extends Life of Heat Exchanger Tubes, and Condenser and Evaporator Tubes.

Here's proof that Chase Antimonial Admiralty gives long life to condenser tubes: *Over 5,000,000 pounds of this patented alloy have been sold without one report of tube failure from dezincification.*

Chase Antimonial* Admiralty combines the best features of plain Admiralty and Red Brass, yet costs no more than either. It will resist sulphur corrosion and is highly resistant to dezincification in corrosive waters. This enables you to reduce inventories by carrying only one stock of tubes.

All common causes of condenser tube failure have been exhaustively studied by Chase Metallurgists. It may pay you to consult these men. There's no obligation. A letter will bring prompt response.

*A PATENTED ALLOY
THE FORMULA FOR CHASE ANTIMONIAL ADMIRALTY IS PROTECTED BY U. S. PATENT NO. 2,061,931

Powerful microscopes are used to check the grain structure of condenser tubes. One of many phases of Chase research to lengthen the life of your condenser tubes.

CHASE BRASS & COPPER CO.
INCORPORATED
SUBSIDIARY OF KENNECOTT COPPER CORPORATION
WATERBURY CONNECTICUT

CHASE
CONDENSER TUBES

Steels for Unusual Service

WHERE equipment must operate at elevated temperatures and high pressures, no ordinary steel will do.

Here is exclusively the field for alloy steels—and in U·S·S Carilloy Alloy Steels we offer you steels that have proved their ability to safeguard performance in cracking units, pressure tanks, pumps and valves, in steam turbines and boilers, super-heaters and high temperature piping.

These superior steels have a demonstrated high resistance to creep. They maintain their strength at elevated temperatures. They are susceptible to heat treatment calculated to develop the optimum properties for high temperature operations. They are developed by our steel technicians working side by side with designers, builders and users of refinery equipment, having always in mind the special and exacting requirements of high temperature operation.

Not only do U·S·S Carilloy Steels meet these requirements but they permit a wide flexibility in selection so that the qualities desirable can be secured to whatever extent called for by the design.

The cooperation of our metallurgists is freely at your service.

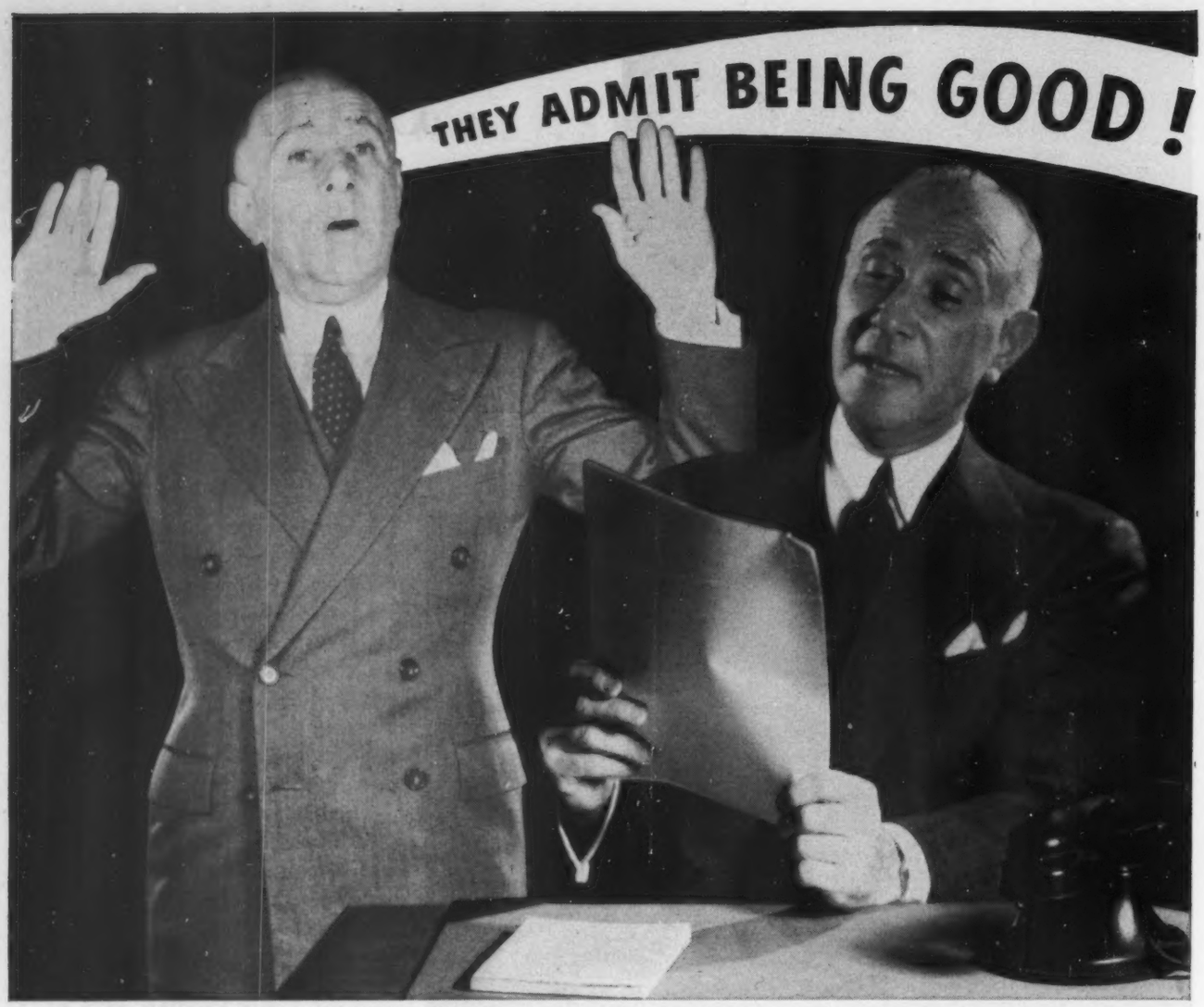
U·S·S CARILLOY ALLOY STEELS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL



ALTER EGO: Literally "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

ALTER EGO: How many have offered you a "good-as-Fleetweld" rod . . . and are they confessing or bragging?

Well, here's the third different welding rod proposition that lays eloquent emphasis on the claim that it's as good as "Fleetweld." *That's stimulating.*

ALTER EGO: No, it's emulating. Emulation admires and strives to imitate great actions. It's a human trait.

That prompts me to ask myself—"Why is 'Fleetweld' taken as the standard of welding electrode comparison?"

ALTER EGO: Maybe Lincoln can give us the FACTS and we can judge for ourselves.

• •

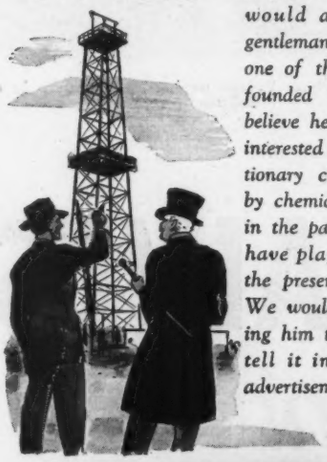
LINCOLN SUGGESTS: To find out why "Fleetweld" is the standard of comparison for welding quality and economy, TRY IT! Compare it to other electrodes. In what ways? See the 30-Point Check Chart on Page 5 of the New "Weldirectory." This 56-page procedure guide (gratis) gives all the FACTS about 37 Lincoln Electrodes for welding and hard-surfacing—where to use them—how to use them—what weld properties to expect.

LINCOLN "SHIELD-ARC" WELDING THE LINCOLN ELECTRIC COMPANY Cleveland, Ohio

Largest Manufacturers of Arc Welding Equipment in the World

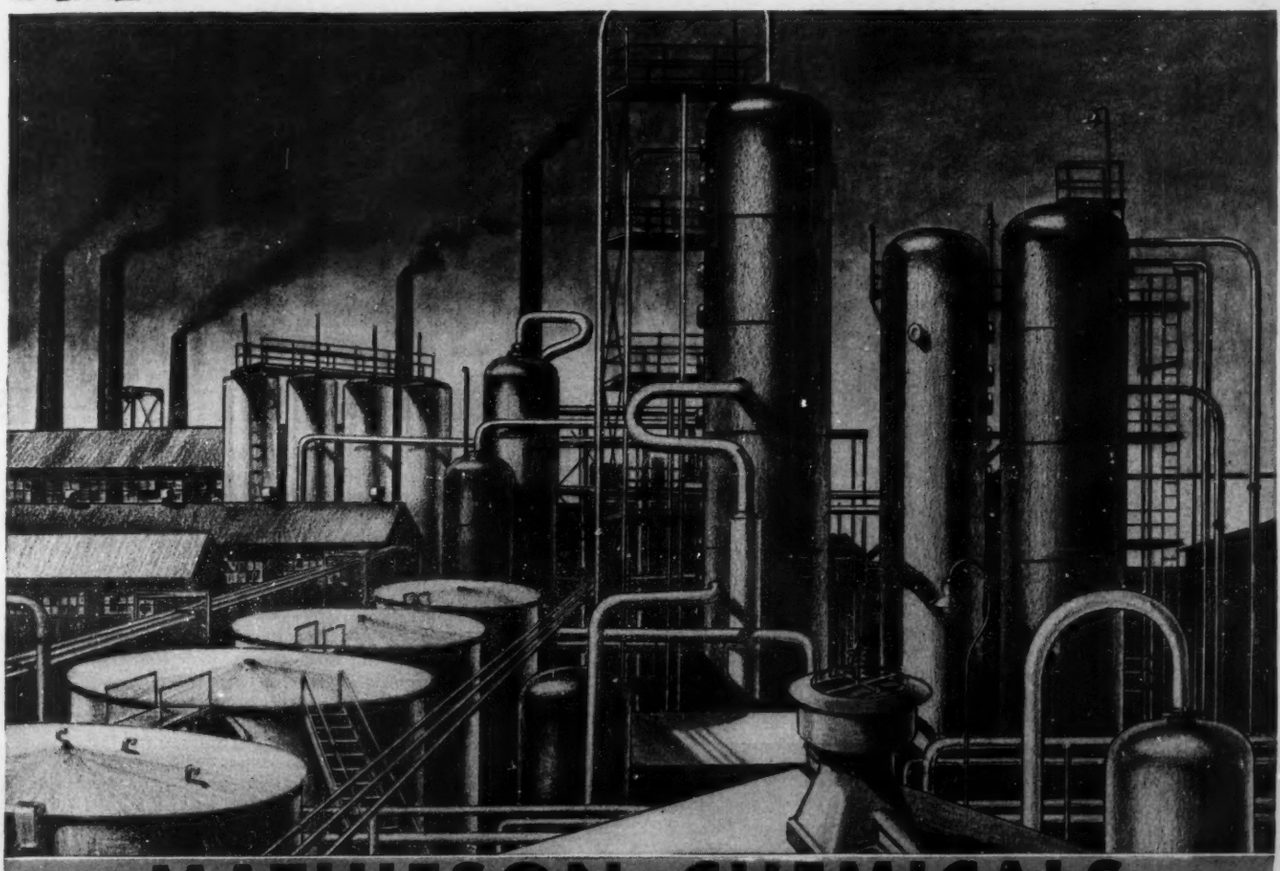
Black Gold!

Suppose someone who lived forty or fifty years ago — say one of the founders of Mathieson — could pay us a visit today. And suppose we could have the pleasure of showing him the sights of 1940, of explaining the vast changes that have taken place since the turn of the century. What do you think would amaze the old gentleman most? If he were one of the pioneers who founded Mathieson, we believe he would be most interested in the revolutionary changes wrought by chemical progress and in the part his successors have played in building the present-day America. We would go about telling him the story as we tell it in this series of advertisements.



● **You look astonished, Mr. M., as well you may. Petroleum's importance was only beginning to be appreciated in your day. You could not foresee the time when it would be one of the prime essentials of industrial civilization, and nations would put a far higher value on the possession of oil fields than on deposits of gold or diamonds.**

The story of oil is the story of our whole modern industrial age — a drama of gigantic growth and development. In the refining end of this great petroleum industry, Mathieson Chemicals play an important part — caustic soda and soda ash as treating reagents, bicarbonate of soda for fire-foam systems, ammonia for refrigeration and for combatting corrosion of equipment, chlorine and hypochlorite for sweetening distillates, for water treatment and for general sanitation. Thus Mathieson products, you'll be proud to know, are contributing in many ways to the continuing development of petroleum in its ever widening service to this nation's industrial life.

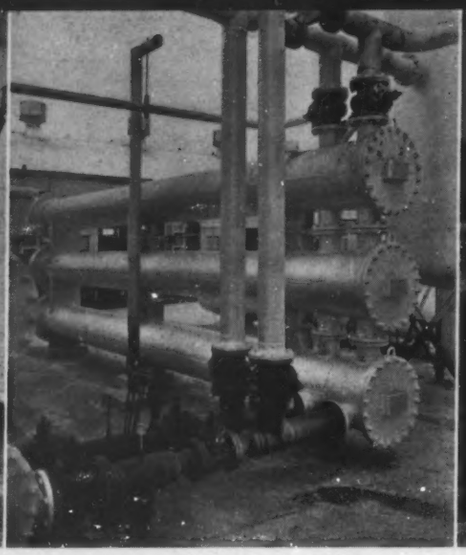


MATHIESON CHEMICALS

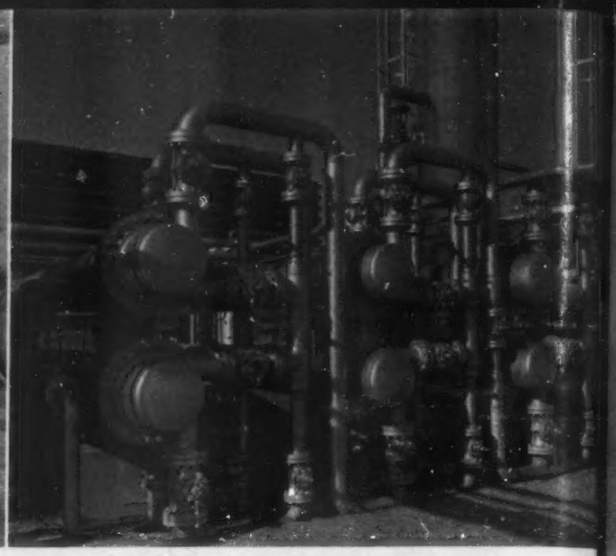
SODA ASH . . . CAUSTIC SODA . . . BICARBONATE OF SODA . . . LIQUID CHLORINE . . . BLEACHING POWDER . . . HTH PRODUCTS . . . AMMONIA, ANHYDROUS and AQUA . . . FUSED ALKALI PRODUCTS . . . SYNTHETIC SALT CAKE . . . DRY ICE . . . CARBONIC GAS . . . ANALYTICAL SODIUM CHLORITE

THE MATHIESON ALKALI WORKS (INC.)
60 E. 42ND STREET, NEW YORK, N. Y.

Nordstrom Hypreseal Multiport high temperature Valves on hot oil service in a midwest refinery.



Nordstrom 4 and 6-inch Valves in a Texas natural Gasoline plant.



Nordstrom Valves on heat exchangers in an Arkansas refinery.

NORDSTROM VALVES

KEEP UPKEEP DOWN

. . . . IN REFINERIES FROM COAST TO COAST

Problem after problem has been placed in the hands of Nordstrom engineers by refinery operators. Valves to meet ever-arising new conditions must be provided. Higher temperatures, corrosion and erosion, and amplified pressures have had to be met. There could be no half-way solution. Nordstrom engineers have tackled these problems with initiative and a definite determination to continue to provide the most efficient valves possible to produce and to maintain leadership. Keep upkeep down with Nordstroms.

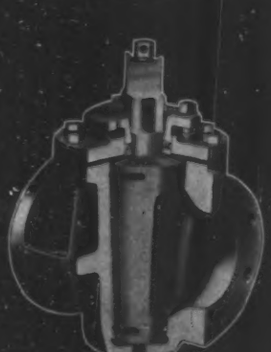
Merchromed Plug "in the rough."

Merchromed Plug, finished.

MERCHROME COATED VALVES

FOR EXTRA HIGH TEMPERATURES

Nordstrom Merchrome Valves open an entirely new field of service in refineries where temperatures run from 500° to 1000° F. and higher. The Merchrome process (patent issued) is a development in which a welded coating is applied to the surfaces of the rotating plug and the interior of the body. The valve is extremely resistant to corrosion and erosion. The impenetrable coating prevents galling and scoring, and shows practically no signs of wear after months of service. Ask for Bulletin.

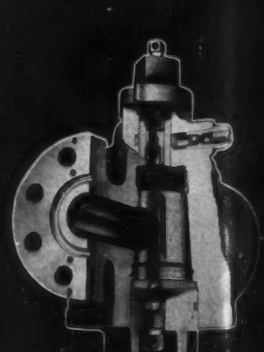


EMCO-NORDSTROM TYPE

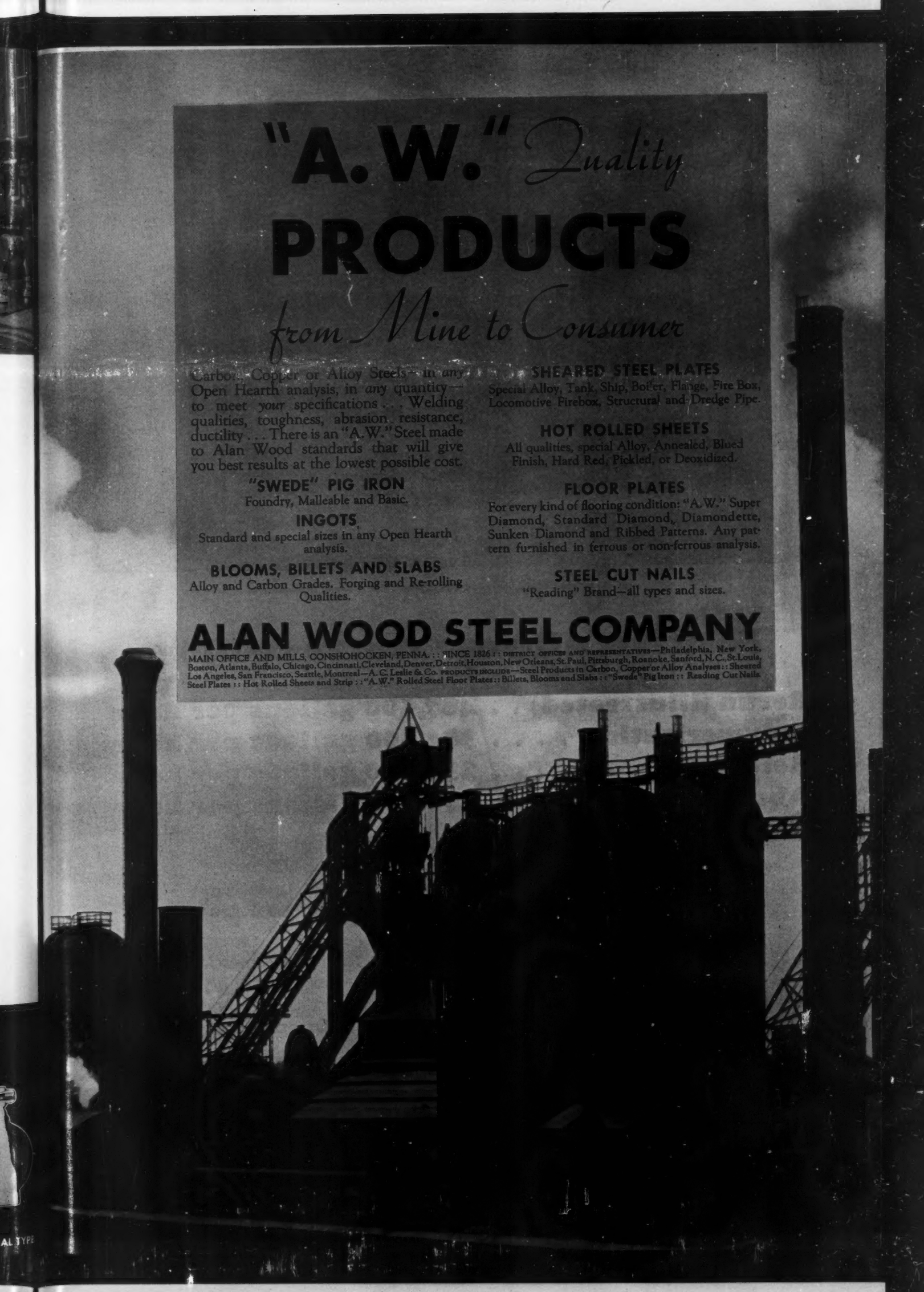
NORDCO STEEL TYPE

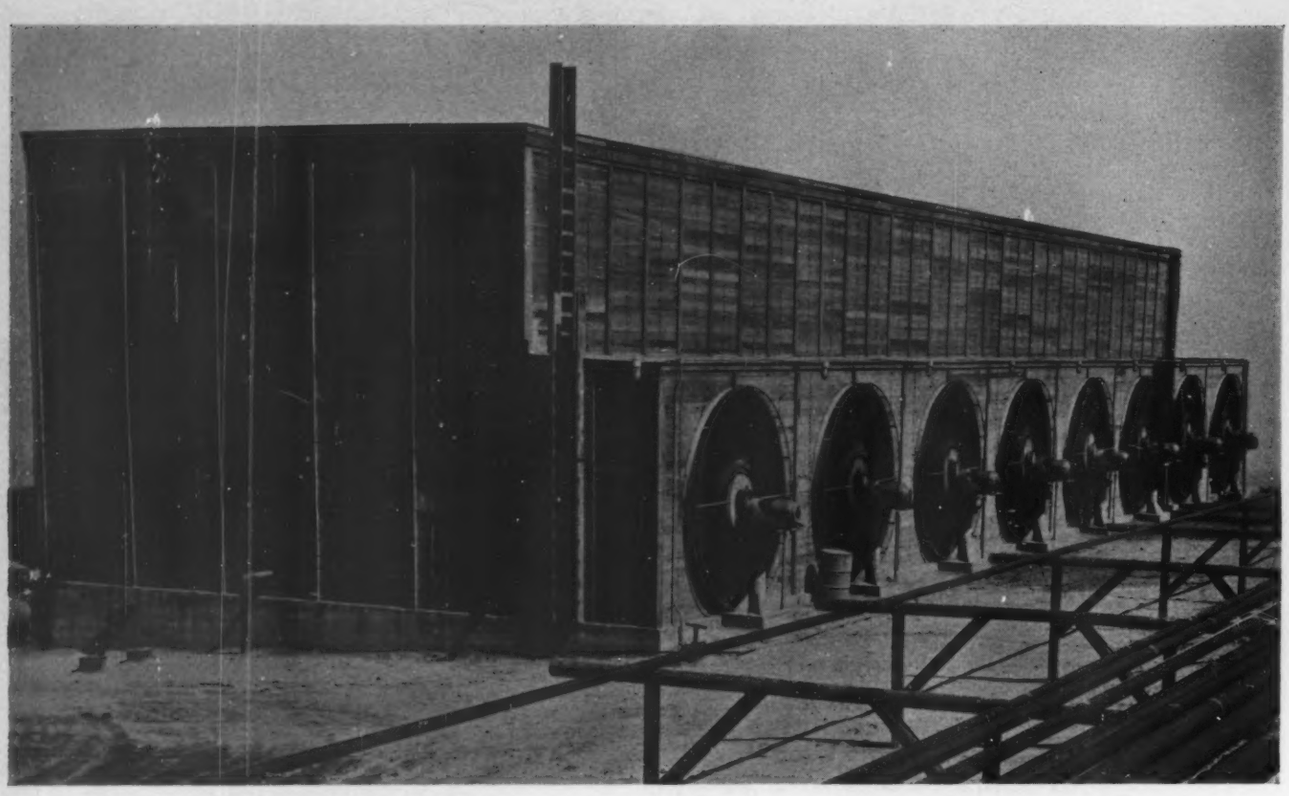
STANDARD TYPE

HYPRESEAL TYPE



Round Opening HYPRESEAL TYPE


"A.W." Quality
PRODUCTS
from Mine to Consumer
Carbon, Copper or Alloy Steels—in any Open Hearth analysis, in any quantity—to meet your specifications . . . Welding qualities, toughness, abrasion resistance, ductility . . . There is an "A.W." Steel made to Alan Wood standards that will give you best results at the lowest possible cost.
"SWEDE" PIG IRON
Foundry, Malleable and Basic.
INGOTS
Standard and special sizes in any Open Hearth analysis.
BLOOMS, BILLETS AND SLABS
Alloy and Carbon Grades. Forging and Re-rolling Qualities.
SHEARED STEEL PLATES
Special Alloy, Tank, Ship, Boiler, Flange, Fire Box, Locomotive Firebox, Structural and Dredge Pipe.
HOT ROLLED SHEETS
All qualities, special Alloy, Annealed, Blued Finish, Hard Red, Pickled, or Deoxidized.
FLOOR PLATES
For every kind of flooring condition: "A.W." Super Diamond, Standard Diamond, Diamondette, Sunken Diamond and Ribbed Patterns. Any pattern furnished in ferrous or non-ferrous analysis.
STEEL CUT NAILS
"Reading" Brand—all types and sizes.
ALAN WOOD STEEL COMPANY
MAIN OFFICE AND MILLS, CONSHOHOCKEN, PENNA. : : SINCE 1826 : : DISTRICT OFFICES AND REPRESENTATIVES—Philadelphia, New York, Boston, Atlanta, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, New Orleans, St. Paul, Pittsburgh, Roanoke, Sanford, N. C., St. Louis, Los Angeles, San Francisco, Seattle, Montreal—A. C. Leslie & Co. PRODUCTS INCLUDE—Steel Products in Carbon, Copper or Alloy Analyses : : Sheared Steel Plates : : Hot Rolled Sheets and Strip : : "A.W." Rolled Steel Floor Plates : : Billets, Blooms and Slabs : : "Swede" Pig Iron : : Reading Cut Nails.



Eight cell, forced draft, low head cooling tower in a Texas Refinery.

Positive, all-year water cooling

Rerun (illustrated) . . 487,500 gallons per hour
Polymerization . . . . 384,000 gallons per hour
Reforming . . . . . 231,840 gallons per hour
Absorber . . . . . 174,000 gallons per hour

The total mechanical draft cooling capacity in this refinery exceeds a million-and-a-quarter gallons per hour, apportioned among four processing units. An assured supply of cool water establishes process production on a year 'round basis.

Flexibility is a definite advantage in low head, mechanical draft cooling systems. Increases in cooling capacity are easily met by the addition of cells at either end of an existing tower without disrupting operation.

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Exterior view type 4655-A with high pressure auxiliary regulator and filter.

Top view of Series 4600-A Intermitter Pilot—Cover open.

Many features mark Fisher Intermitters as outstanding in providing trouble-free, dependable service. The Intermitter Pilot assembly is compact — it is ruggedly engineered and constructed, and all pilot parts and clock are enclosed in a weather-proof, gas-tight case of high tensile iron which is cast integral with the upper diaphragm casing. Length and frequency of operating intervals can be easily varied to meet all conditions.

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1 — Intermittent control (of high pressure gas for) gas lifting operations.

2 — Automatic "stop-cocking" of high gas oil ratio wells or distillate wells.

3 — Controlling production periods of wells under pro-ration.

4 — Controlling high pressure operating mediums to production devices.

WRITE FOR SPECIAL INTERMITTER BULLETIN 80-C. GIVES COMPLETE SPECIFICATIONS AND PRICES

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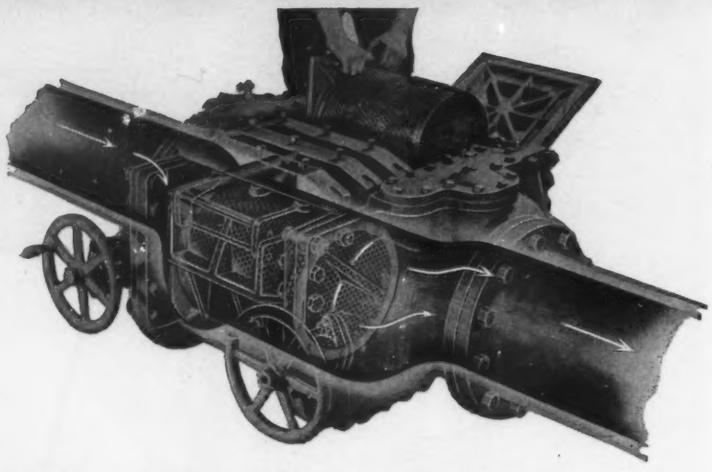

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Built on the twin strainer principle, adapted to use with fuel and lubricating oil. The simple way to provide non-stop safety insurance for oil burners, pumps, and other oil handling equipment. Sizes 1" to 12".

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Cleans itself as well as the water. Requires no maintenance beyond occasional general inspection. Back-flow flushes each straining section in turn. Cannot be clogged by matting of fibrous material. Lower thrust bearing immune to scoring by foreign particles. Easily installed anywhere in the line. Sizes from 4" to 24".

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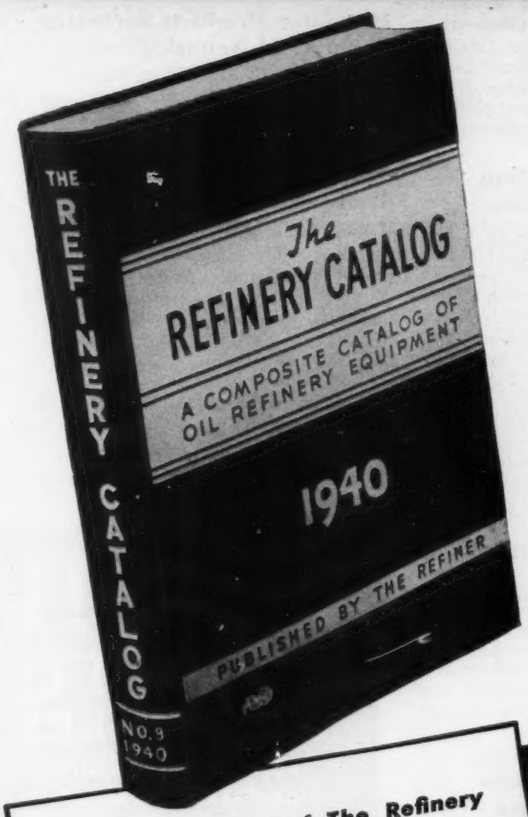
Refinery Equipment



"The convenience of The Refinery Catalog and the fact that it contains such a wealth of equipment and process data in a single volume makes it the logical starting place in searching for information."

MEN WHO BUY, specify and requisition equipment and materials in refineries the world over *say they find The Refinery Catalog of genuine time-saving usefulness and value.*

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HIGH TEMPERATURE

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CHIKSAN BALL BEARING SWING JOINTS

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BUSINESS NOTES

Praeger and Lyster Advanced By Alcorn Combustion Company

Frank H. Praeger and Roy S. Lyster have been named president and vice president, respectively, of Alcorn Combustion Company, Philadelphia, and both have been added to the directorate.

A graduate of the University of Pennsylvania in 1923, Praeger joined the company in 1926 as sales engineer. He was in charge of the company's first branch office in Tulsa, and later in Los Angeles and San Francisco, and in 1935 was made sales manager.

Lyster graduated from the University of Pennsylvania in 1919 and received his early engineering experience with Henry Disston & Sons, The Barrett Company, and Atlantic Refining Company. He joined the engineering force of Alcorn Combustion Company in 1927 and in 1935 was made chief engineer.

Du Pont Starts Construction Of Neoprene Plant Addition

E. I. du Pont de Nemours & Company has started construction on a further addition to its neoprene plant at Deepwater Point, New Jersey, with completion scheduled for October, 1941. It will supplement a plant addition of the same size which has just been finished.

Together, the two additions will increase neoprene capacity by 1,000,000 pounds per month, raising production facilities to 1,500,000 pounds per month, six times the capacity available in the summer of 1939.

Keasbey & Mattison Enlarges All Research Facilities

Keasbey & Mattison Company, Ambler, Pennsylvania, has combined all research facilities for its various products in a new enlarged research department headed by Clyde R. Hutchcroft, and with William R. Morris as general consultant.

Bethlehem Steel Announces Maryland Pipe Warehouse

Bethlehem Steel Company, Bethlehem, Pennsylvania, has announced plans for a new pipe warehouse and increased finishing capacity to round out facilities at its new continuous-weld pipe mill at its plant at Sparrows Point, Maryland. The warehouse will increase storage facilities 70 percent. Completion is scheduled for early summer.

Allegheny Ludlum Erecting New Los Angeles Warehouse

Allegheny Ludlum Steel Corporation has announced construction of a new warehouse on Pacific Boulevard, Los Angeles. The new building will be a concrete industrial building.

Worthington Pump Enters Water Purification Field

Worthington Pump & Machinery Corporation, Harrison, New Jersey, has announced its entry into the water-purification field.

The company has completed research and design standards for hot-process water softeners and pressure filters for all capacities. Chemical and other technical departments, as well as manufacturing facilities, have been supplemented to accommodate requirements of water purification service.

Forster Torches Distributed by Bastian-Blessing Company

Distribution of Forster torches, designed for use with butane and propane gases and made by Ransome Company has been assumed in all territories east of the Rocky Mountains by The Bastian-Blessing Company, 242 East Ontario Street, Chicago.

Purolator Products Increases Capacity of Newark Plant

Purolator Products, Inc. has completed an additional 15,000 square feet of factory space at its plant at Newark, New Jersey, according to E. B. Headden, vice president in charge of production.

Rollway Bearing Company Erecting Plant Addition

Rollway Bearing Company, Syracuse, New York, has started construction of a plant addition for bearing assembly and shipping facilities. On its completion, rearrangement of present plant departments will be made.

Blackmer Pump Reorganizes Divisional Sales Organization

Reorganization of the divisional sales organization of Blackmer Pump Company, Grand Rapids, Michigan, has been

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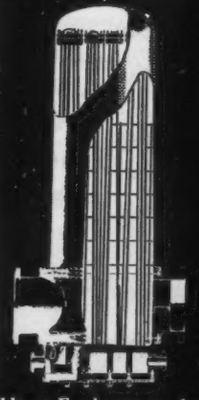
for High Pressure and Temperature.



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Steam IS money. Wasting steam boosts overhead—eats up income—shrinks profits. Steam accounting is serious business—it needs business methods.

As a modern cash register guards a storekeeper's dollars—producing a printed record of each transaction—so flow meters should guard your power and process steam.

With Brown Flow Meters measuring the flow of fluids for power, heating and processing, you are completely protected—because

The Brown Automatic Recording Planimeter Pen, "A", making the marginal record shown on the chart pictured supplies the PROOF that a definite number of pounds of steam, gallons of water, cubic feet of gas, or barrels of oil, were delivered, utilized—or wasted.

This is a special, patented feature of the greatest value to flow meter users. Reference to the automatic planimeter pen record on chart rim assists you to distribute departmental or process loads more uniformly over the working day, effecting substantial fuel savings not only in the boiler room but in every department or unit where steam is used.

In addition, Brown Flow Meters offer you other advantages such as:

Six inter-related range tubes with inter-related direct reading charts.

Meter Bodies for working pressures up to 2500 lbs.

Integrator dial—easy to read—insures highly accurate totalizing at all rates of flow from 0-100%.

Universal case permits any style panel mounting — flush on panel, front-of-board or on wall.

Indicating, Recording and Controlling models—Electrical, Mechanical and Area types for all applications.

Get all the facts about Brown Flow Meters. Features are fully explained in Catalog No. 2007. Send for your copy. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., 4498 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street—Amsterdam-C Holland: Wijdesteeg 4—England: Wadsworth Road, Perivale, Middlesex—Stockholm, Sweden: Nybrokajen 7.

"A" This automatic planimeter pen record shows steam flow in volume units and the time at which it was produced or used in any part of the 24 hour period, enabling you to easily analyze steam production and distribution.
"B" This record line shows rate of flow and enables the operators to maintain the most efficient boiler operation, thus effecting substantial fuel savings.

BROWN Flow Meters

Accurate Measurement with Simplicity

DAVENPORT WOOD SOLES are designed for use in refineries where underfoot conditions are too tough for ordinary soles. WOOD SOLES provide safer footing on slippery floors and rough, uneven surfaces. Tough maple soles, cut for comfortable walking, long outwear ordinary soles. Also special shoes designed to meet your particular requirements. It will pay you to investigate DAVENPORT WOOD SOLE SHOES. *WRITE for FREE CATALOG and latest prices!*

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announced by N. J. Harkness, executive vice president and general manager.

Bruce P. Hetler, former general sales manager, has been named manager in charge of engineering sales, while J. B. Trotman, former manager of the turbine pump division of Roots-Connersville Blower Corporation, has been appointed general sales manager in charge of sales distribution and advertising.

Supply Personals

Dr. W. D. Coolidge and Stuart M. Crocker have been named vice presidents of General Electric Company. Coolidge will continue as director of the General Electric Research Laboratory in Schenectady, New York. Crocker will relinquish his duties as manager of the company's air conditioning and commercial refrigeration department at Bloomfield, New Jersey, to make his headquarters in New York City where he will cooperate with and be assisted by all commercial departments.

W. C. Buchanan, president of Globe Steel Tubes Company, Milwaukee, has been elected a member of the board of directors of Allis-Chalmers Manufacturing Company, Milwaukee.

John H. Walker, Beaumont, has been named salesman in the Dallas territory for P&H welders and electrodes of Harnishfeger Corporation, Milwaukee.

Paul Keller has been named by Copperweld Steel Company, Warren, Ohio, as Cleveland district manager in charge of sales of Aristoloy alloy steels. A graduate of the University of Tennessee, he was previously connected with Mid-States Steel & Wire Company and Bethlehem Steel Company in Baltimore, Bethlehem and Cleveland offices.

R. A. Karr, formerly employed by Battelle Memorial Institute and later by the Central Alloy Division of Republic Steel Company, has joined Copperweld Steel Company, Warren, Ohio, as metallurgist.

Edward A. O'Neal, Jr., manager of the Anniston plant of the Phosphate Division of Monsanto Chemical Company, St. Louis has been named manager of the company's new plant under construction at Trenton, Michigan. He will go to Trenton shortly after January 1. E. J. Swanson, chief clerk at Anniston, has been transferred to the new plant to handle accounting work at the field office, and with completion of the plant will become office manager.

T. T. Watson, development and service metallurgist for Lukens Steel Company, Coatesville, Pennsylvania, since 1934, has been appointed research metallurgist in charge of all plant research.

Earl G. Morgan has joined the air conditioning and refrigeration division of Worthington Pump & Machinery Corporation, and will make his headquarters in the company's Kansas City office. He has served as sales manager of the refrigeration department of United Iron Works Company, Springfield, Missouri; was with Frick Company at Dallas, and for nine years was district representative at Kansas City for Vilter Manufacturing Company.

W. Riley Workman, 46, sales engineer at Dallas for Pittsburgh-Des Moines Steel Company, died November 12 following an operation. A graduate from Iowa State University in 1916 with a degree B. S., he immediately associated himself with the company, serving first at the general office in Pittsburgh and later in the Dallas sales office.

Walter W. Brown, with the Ralph M. Brodie Company, Oakland, California, for the past 14 years, has been appointed vice president of Smith Meter Company, Los Angeles.

S. R. Clingan, formerly with Republic Steel Corporation, has been named Chicago district manager in charge of Aristoloy alloy steels for Copperweld Steel Company, Warren, Ohio.

Just Published **275 pages**

"Naphthenic Lubricants and Allied Products"

DR. A. J. KRAUS
Consulting Chemist
PRICE $15.00

A practical guide dealing with the use and adaptation of naphthenics and their derivatives in the manufacture of lubricating and processing products.
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THE ONLY HANDBOOK OF BUTANE-PROPANE GASES

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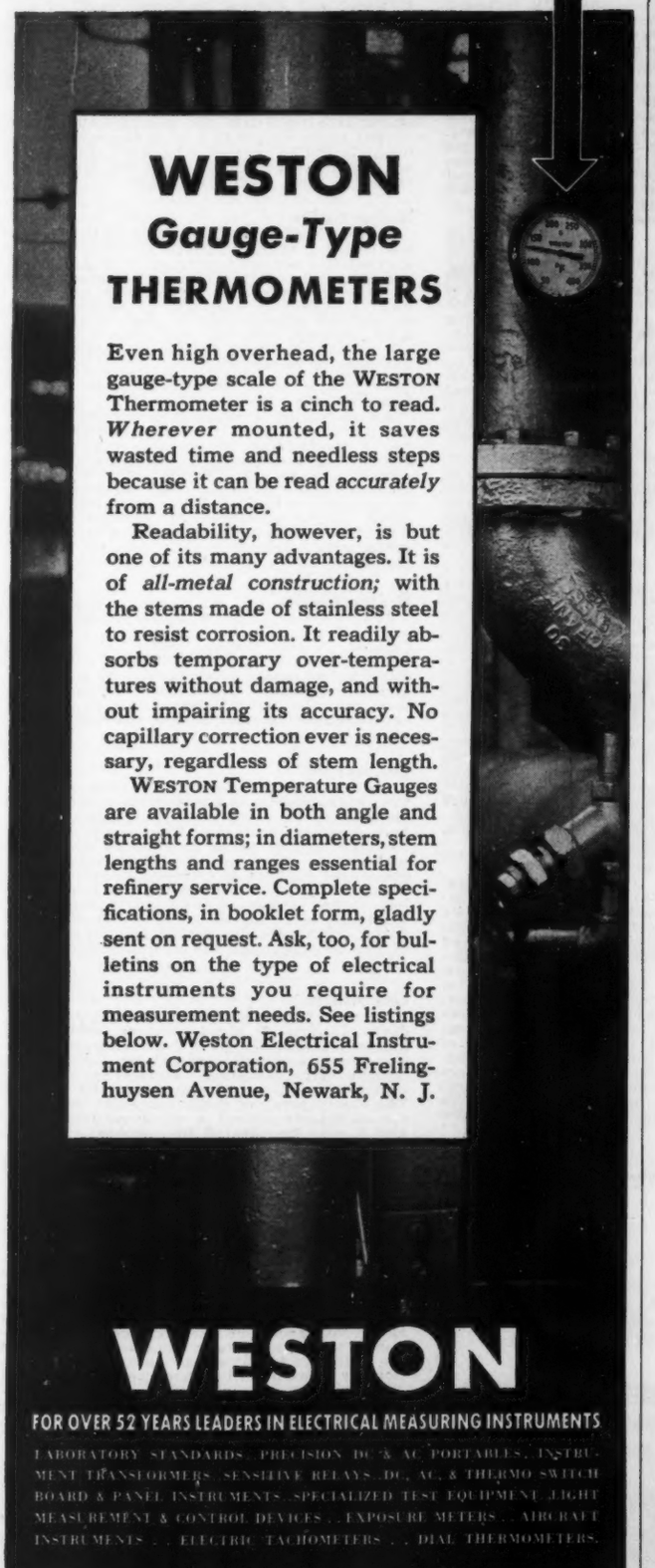

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Gauge-Type THERMOMETERS

Even high overhead, the large gauge-type scale of the WESTON Thermometer is a cinch to read. *Wherever* mounted, it saves wasted time and needless steps because it can be read *accurately* from a distance.

Readability, however, is but one of its many advantages. It is of *all-metal construction;* with the stems made of stainless steel to resist corrosion. It readily absorbs temporary over-temperatures without damage, and without impairing its accuracy. No capillary correction ever is necessary, regardless of stem length.

WESTON Temperature Gauges are available in both angle and straight forms; in diameters, stem lengths and ranges essential for refinery service. Complete specifications, in booklet form, gladly sent on request. Ask, too, for bulletins on the type of electrical instruments you require for measurement needs. See listings below. Weston Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark, N. J.

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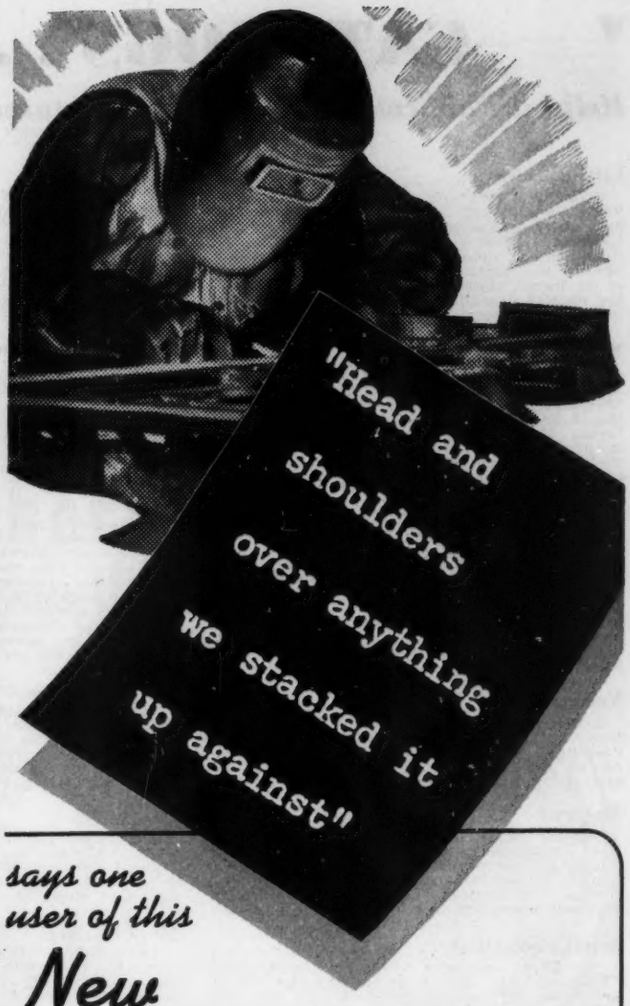

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Many other users have the same high opinion of this new Page-Allegheny Stainless Steel Electrode. One of the world's largest users of stainless steel electrodes, for example, has standardized on it 100%.

This electrode, the 22nd variation of the 473rd formula tried out in the Page Research Laboratory is the product of a long, arduous program of research and experiment.

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BUY ACCO QUALITY *in Page Welding Electrodes; Page Wire Fence; Lay-Set Preformed Wire Rope; Reading-Pratt & Cady Valves; Campbell Cutting Machines; American Chains; Ford Chain Blocks, Cranes and Trolleys.*

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CATALOGS . . . BULLETINS

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Lifting Device

Economy Engineering Company, 2653 West Van Buren Street, Chicago, has issued a 32-page catalog describing its line of lifting and hoisting devices for use in machine shops, warehouses, factories and stores. Also described are platforms to facilitate handling of oil drums, skids and pallets, and for dumping barrels. Installation views supplement details of construction and specifications.

Welding Nickel Alloys

The International Nickel Company, 67 Wall Street, New York, has issued Bulletin T-2 on "Welding, Brazing and Soft Soldering of Monel, Nickel and Inconel." The bulletin numbering 32 pages, contains numerous photographs and drawings to illustrate procedures. Included is a list of other technical bulletins on monel, nickel and nickel alloys.

Welders

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, has issued Catalog Section 26-320, containing four pages descriptive of its Midget Marvel Flexarc AC welder. It contains descriptions of construction and operational features, illustrations, and suggested applications in commercial and industrial fields. A graphic chart gives power costs in cents per hour of operation.

Voltmeter

General Electric Company, Schenectady, New York, has issued Bulletin GEA-3020A describing its electrostatic voltmeter, designed for AC and DC measurements of voltages on systems where one line is grounded.

Motors

General Electric Company, Schenectady, New York, has issued Bulletin 831 giving 20 pages of performance records on electric motors in various applications. A section describes and illustrates factory tests to which they are subjected.

Metal Protection

The Flood Company, 6217 Carnegie Avenue, Cleveland, has issued a bulletin describing properties of Penetrol, designed as a base for paint that may be applied upon a rust surface. It is described as a blend of natural oils containing no volatiles, and is also intended as a reinforcing reducer for paints and a vehicle for aluminum pigments.

Gas Cutting Machines

Air Reduction, 40 East 42 Street, New York, has issued a 24-page bulletin covering four gas cutting machines designed to cut an unlimited variety of shapes from steel plate, slabs, billets and forgings. The machines are the No. 6-A Oxygraph and the Nos. 10, 40 and 41 Travographs. The first section of the bulletin pictures suggested applications, with the second half devoted to individual treatment of each of the machines.

Water Coolers

Condenser Service & Engineering Company, 310 Twelfth Street, Hoboken, New Jersey, has issued Bulletin W-100 describing its jacket water coolers. Construction features are discussed and illustrated. Tables give specifications of individual units.

Tubing

Summerill Tubing Company, Bridgeport, Pennsylvania, has issued an 8-page bulletin on "Taking 'Specials' in Stride," featuring the company's facilities for runs of tubing to meet exceptional specifications. It is intended to show by example how the company functions to bring advantages of seamless tubing to users whose needs are not covered by ordinary mechanical stocks.

Hose and Couplings

Pennsylvania Flexible Metallic Tubing Company, 72 Street & Powers Lane, Philadelphia, has issued Bulletin 52-G, giving eight pages descriptive of its line of bronze steam hose and clincher couplings. The hose is offered in plain, wire braided and armor-over-braid styles, while the couplings are designed to permit full flow through joints.

Jacks

Templeton, Kenly & Company, 1020 South Central Avenue, Chicago, has issued a 60-page catalog designated No. 40 and of a size that will fit into the vest pocket, describing construction, application and giving specifications for more than 300 sizes and types of the company's Simplex jacks. It covers automatic raising and lowering jacks, screw jacks, journal jacks, geared jacks and specialized jacks for the oil and other industries.

Floor Furnaces

John Zink Company, 4401 South Peoria Avenue, Tulsa, has issued an 8-page booklet on its line of floor furnaces. The units, which employ one-port type burners and operate on natural or butane gas, are available in capacities of 25,000-Btu, 50,000-Btu and 68,000-Btu.

Chemicals

The Edwal Laboratories, Inc., 732 Federal Street, Chicago, has issued a 16-page booklet listing its line of chemicals and describing its services. It gives specifications of the chemicals, uses, shipping classification and packing.

Air Cleaning

Westinghouse Electric & Manufacturing Company, Edgewater Park, Cleveland, has issued Folder F-8501 entitled "Dirt Is a Critical Hazard," and describing application, operation and dirt-removing qualities of the company's Precipitron electrostatic air cleaner. The folder describes the device and describes its operation. Installation and cleaning capacities are briefly covered, with a cut-away picture of a typical installation included.

Fabricating Stainless

Ingersoll Steel & Disc Division, Borg Warner Corporation, 310 South Michigan Avenue, Chicago, has issued a new edition of its booklet on "Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel." Its 16 pages provide a new presentation with revised text and diagrams illustrating welding and fabricating procedures. Improvements in technique to provide maximum strength, corrosion resistance and ductility in welded fabrication have been emphasized. The manual includes discussion of forming, bending, welding, heat-treating, cleaning, grinding and polishing of stainless clad steel, and a chart showing corrosion resistance of two types of IngAclad steel to a list of acids, alkalis and other corrosive liquids and materials in common usage.

Pumps and Pump Parts

The International Nickel Company, 67 Wall Street, New York, has issued a 16-page booklet on "Practical Pumping Problems and How they Are Solved," discussing uses of Monel, K Monel and S Monel for pump parts in applications where there is need for high resistance to corrosion wear, pitting or scoring. Part of the book is devoted to a review of case histories. Performance data is given on pumps in applications which suggest how savings may be made in maintenance and replacement costs. Attention is given to choice of suitable materials for pumps handling a variety of corrosives in a wide range of industries, including power, chemical, municipal water supply, processing, railroad, steamship operation, and diversified fields.

Refractories

General Refractories Company, Philadelphia, has issued a 48-page bulletin on "World-Wide Refractories Service," printed in English and Spanish, and covering descriptive information on all major types of refractories and their uses. It describes methods of shipment for export, and incorporates 10 pages of tables of sizes, weights, volumes and general data as are usually required in use, application and purchase of refractories.

Gas Cutting

Air Reduction, 40 East 42 Street, New York, has issued an 8-page illustrated bulletin on its No. 4 Radiagraph, a portable motor-driven gas-cutting machine. The equipment is designed to make straight-line cuts, for cutting arcs or complete circles, and for cutting irregular shapes involving long sweeping curves, either simple or compound. Included is a description of flame-hardening and plate-edge preparation operations that may be accomplished by using special equipment.

Roller Chain

The Whitney Chain & Manufacturing Company, Hartford, Connecticut, has issued Catalog V-150 listing roller chains and sprockets available as stock items at central distribution points. Numbering 20 pages, it gives information, in condensed form, helpful in selection of stock drives. Location of sales and engineering offices and distributors is given.

Discharger

Cochrane Corporation, 17 & Allegheny Avenue, Philadelphia, has issued Publication 2935 describing its dischargers for high-capacity high-pressure drainage. The equipment, by means of a pilot valve, applies the steam line pressure to open the discharge valve. Displacement weights of different densities move the pilot control valve. When the pilot valve has opened, steam is admitted to the top of the main valve piston, opening the discharge valve. Drains are discharged from the bottom of the body through the eduction pipe to the outlet.

Gas Alarm

Mine Safety Appliances Company, Braddock, Thomas & Meade Streets, Pittsburgh, has issued Bulletin DT-2 describing its explosion-proof combustible gas alarm designed for continuously sampling atmospheres where combustible gases and vapors may be present. The device provides instant warning when gas concentrations exceed a predetermined limit, and it may be adapted for automatic process or ventilation control.

Hard Facing

International Stellite Corporation, 30 East 42 Street, New York, has issued three booklets in Spanish comprising selections of a series of hard-facing data sheets. Form 4586, captioned "Stelliting Steel Wearing Surfaces by the Oxy-Acetylene Process," describes steps in surface preparation, preheating, flame adjustment, depositing Stellite, cooling, finishing and other considerations in applying Stellite by the oxy-acetylene process. Form 4585, captioned "Stelliting Steel Wearing Surfaces by the Metallic Arc Process," describes application by the metallic arc process to typical parts whose service conditions permit application by the process. Subjects include surface preparation, preheating, applying Stellite with the direct-current arc, applying with alternating-current arc, laying a second bead, depositing a second layer, cooling, and finishing. Form 4587, on "Hard-Facing and Hard-Setting Wearing Parts in Oil Fields and Refineries," discusses procedures for application of hard-setting materials to such parts as rock bits, and core heads, and of hard-facing materials to side-tracking mills, ditching machine teeth, pump shaft sleeves, tube cleaners and similar equipment.

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Time Switches

General Electric Company, Schenectady, New York, has issued Bulletin GEA-2753 illustrating and briefly describing its hook-on volt-ammeter, portable test instruments, inkless recording instruments, strip-chart recording instruments, round-chart recording instruments, Type KT time meters, general-purpose automatic time switch, automatic process time switch, and automatic repeating time switch.

Refractories

Mexico Refractories Company, Mexico, Missouri, has issued an illustrated booklet commemorating its tenth anniversary. It traces history of the company and illustrates mining of clay and manufacture of refractories.

Blowers

Roots-Connersville Blower Corporation, Connersville, Indiana, has issued Bulletin 21-B-35 describing its Victor-Acme rotory positive blower for handling small and medium volumes of air against pressure or under suction, ranging from 8 ounces to 7 pounds per square inch. The bulletin describes the general operating principle of the blower, gives a table of ratings of the several different sizes, and illustrates the blower in arrangements in which it is furnished.

Inhalator

Mine Safety Appliances Company, Braddock, Thomas & Meade Streets, Pittsburgh, has issued Bulletin CA-9 giving six pages descriptive of its Model H-H inhalator for resuscitation of victims of respiratory failure. The instrument is designed to supply the lungs of the patient with the correct mixture of oxygen and carbon dioxide for recovery without possibility of harm to the delicate respiratory system.

Hard Rubber Equipment

The Luzerne Rubber Company, Trenton, New Jersey, has issued a 20-page bulletin on its line of hard rubber equipment for handling corrosive solutions. It describes pipe and fittings; check and foot valves; globe, angle and straightway valves; float valves; gauge glass fittings; pet cocks and bibcocks; acid handling containers, and centrifugal pumps. Lining and covering of castings with hard rubber are discussed.

Portable Compressors

Chicago Pneumatic Tool Company, 6 East 44 Street, New York, has issued the fourth edition of its Bulletin 758 describing its line of two-state air-cooled portable compressors. The entire line has been streamlined. The bulletin illustrates various models and gives specifications, dimensions and weights.

Condensers and Heat Exchangers

The American Brass Company, Waterbury, Connecticut, has issued the fifth edition of Bulletin B-2 giving 60 pages of data on condenser and heat-exchanger tubes and plates. It includes discussions on corrosion factors; tube and plate alloys; methods of manufacture; applications in oil refining, stationary steam plants and ships; installation data, tentative specifications of the American Society for Testing Materials, and an appendix covering physical properties, weights, carrying capacities, tables on temperature conversion, steam pressures, and the Mollier diagram.

Fire Brick

A. P. Green Fire Brick Company, Mexico, Missouri, has issued a technical data bulletin on its insulating fire brick. It gives suggestions on selection of fiire brick, describes types available, and gives graphs on thermal conductivity, insulating properties, thermal expansion, and physical strength.

Electronic Devices

General Electric Company, Schenectady, New York, has issued a 20-page booklet on "Electronic Devices for Industry," briefly listing some of the more important vacuum-tube apparatus and describing its application and method of operation. It deals with phototubes, DC motor control, recording spectrophotometer, exposure meters, pyrometers, gas-discharge and high-vacuum electronic tubes, the Reactrol system, automatic arc-welding equipment, ignition rectifiers, resistance welding, and battery-charging equipment.

Panel Instruments

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, has issued Catalog Section 43-370 covering its No. 37 line of miniature panel instruments. Approximately 4½ inches in diameter, the instruments are available in three mounting styles and have a broad field of application, from industrial and radio test apparatus to the gadget of the amateur experimenter. The catalog explains features such as dial readability, and interchangeability of instruments. Operating principles are described and illustrations of the instruments are included.

Refractories

The Carborundum Company, Refractory Division, Perth Amboy, New Jersey, has issued a 76-page bulletin entitled "Super Refractories." It gives refractory properties of silicon carbide, fused aluminum oxide, Mullite, and aluminum silicate refractories. A series of charts compare physical properties, and pictures show applications of the different products.

Pipe Tools

Beaver Pipe Tools, Inc., Warren, Ohio, has issued a bulletin briefly describing its line of tools and quoting statements of users concerning their operation.

Regulators

The Chaplin-Fulton Manufacturing Company, 28-40 Penn Avenue, Pittsburgh, has issued Bulletin 130 describing its line of regulators for compressor control. The device is offered to control pressure at the discharge of a constant-speed pump. When installed in the by-pass from the discharge line to the suction line of a compressor, it is designed to relieve excess pressure by recycling it through the compressor.

Fire Protection

Walter Kidde & Company, Bloomfield, New Jersey, has issued Bulletin 508, comprising eight illustrated pages on built-in carbon dioxide fire extinguishing systems. It describes problems involved in adapting this method of fire protection to various industrial hazards.

Cutting Steel

McKenna Metals Company, Latrobe, Pennsylvania, has issued a chart listing horsepower requirements for cutting steel with Kennametal-tipped tools. The chart is designed to enable the tool supervisor to advise the machine operator what depth and feed the machine will pull in cutting steel with Kennametal tools.

Motor Control

Electric Machinery Manufacturing Company, Minneapolis, Minnesota, has issued Bulletin 159 giving eight pages describing polarized field frequency automatic control for synchronous motors. Function and construction of the control parts are explained, and connections of a typical control are illustrated.

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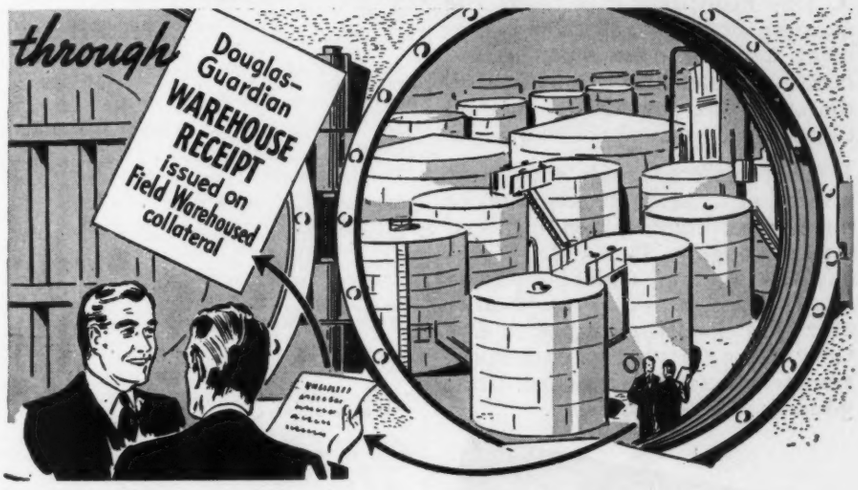

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OIL BOOKS

The knowledge gained through years of work and study by some of the most capable men in the oil industry is set down in the various oil books published and sold by the Gulf Publishing Company. For information on oil books see pages 70 and 204 of the 1940 Edition of the Composite Catalog of Oil Refinery Equipment. Catalog of oil books furnished upon request.

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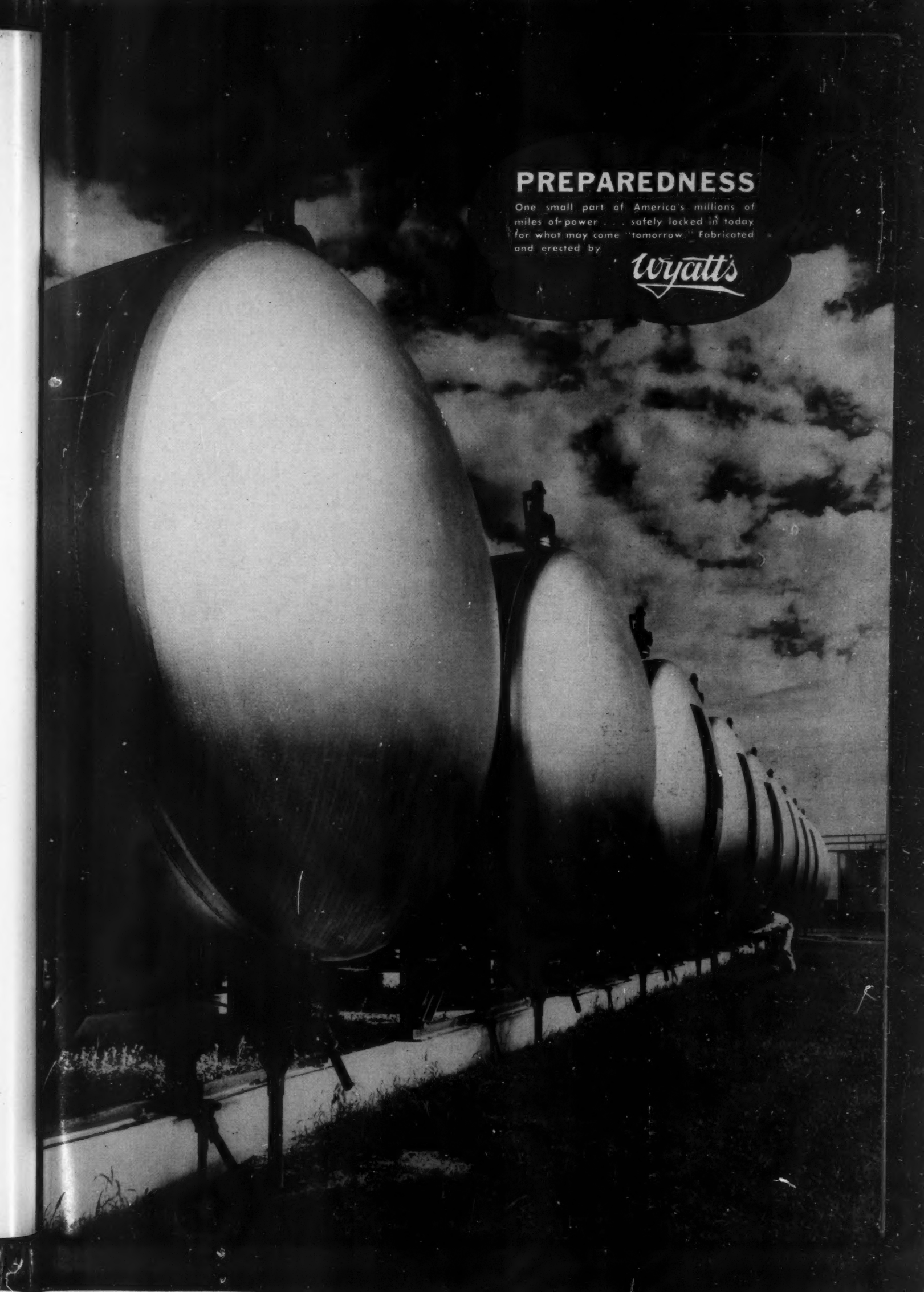
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...due to Excessive Pressure Caused by Expansion

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4-Inch Flanged Type Rising Stem O. S. & Y. or Non-Rising Stem

Plate 860-N
Patented

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Iron body . . . solid wedge . . . bronze faced . . . guided both sides . . . bronze seats . . . bronze stem.

For the Rising Stem Type, O. S. & Y., specify Plate 860-R.

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In addition to the 4″ size, McDonald Expansion Relief Gate Valves are available in 2″, 2½″ and 3″ sizes. The 2″ are all bronze screw type; the 2½″ and 3″ sizes are iron body, bronze mounted, screw or flanged type:

Plate 858
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For Standard Type (as illustrated) specify Plate 858. 2″, 2½″, 3″.

For Lock Type (with locking device) specify Plate 859. 2″, 2½″, 3″.

For Flanged Standard Type—iron body, bronze mounted—specify Plate 860. 2½″, 3″.

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